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WATER RESOURCE DEVELOPMENT FOR EAST-CENTRAL OKLAHOMA

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PLANNING GUIDE

MARCH 1985

U.S. DEPARTMENT OF INTERIOR
BUREAU OF RECLAMATION
SOUTHWEST REGION

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GUIDE TO PHOTOGRAPHS ON REPORT COVER

A farmstead, small feedlot, and modest water storage structure illustrate the agricultural and rural dependence on adequate supplies of good water.

This gas-fired generating plant uses flows of the North Candian River for cooling water. Note the intake works in the river. Municipality in the background is Weleetka in Okfuskee County.

Located in the extreme northwest of the study area, beautiful Sooner Lake serves as a cooling water reservoir for Oklahoma Gas and Electric large coal-fired generating plant.

Lake Holdenville's sky-blue waters serve as a municipal water supply source and also support operations of a State-owned fish hatchery.

PLANNING GUIDE
TO
WATER RESOURCE DEVELOPMENT FOR EAST-CENTRAL OKLAHOMA

PREPARED BY

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

SOUTHWEST REGIONAL OFFICE

AMARILLO, TEXAS

MARCH 1985

DISCLOSURE

THIS PLANNING GUIDE IS CONSIDERED TO BE A WORKING DOCUMENT LEADING TO THE PREPARATION OF THE BUREAU OF RECLAMATION'S FINAL REPORT OF THE EAST-CENTRAL OKLAHOMA WATER SUPPLY STUDY. ALL DATA ARE PRELIMINARY AND SUBJECT TO REVISION. PUBLICATION OF THE FINDINGS AND CONCLUSIONS HEREIN SHOULD NOT BE CONSTRUED AS REPRESENTING EITHER THE APPROVAL OR DISAPPROVAL OF THE SECRETARY OF THE INTERIOR. THE PURPOSE OF THIS DOCUMENT IS TO PROVIDE INFORMATION FOR FURTHER CONSIDERATION BY THE BUREAU OF RECLAMATION , THE SECRETARY OF THE INTERIOR, OTHER FEDERAL AGENCIES, STATE AND LOCAL AGENCIES, AND THE GENERAL PUBLIC.

ABBREVIATIONS

bbl - barrel

COEDD - Central Oklahoma Economic Development District

Corps - U.S. Corps of Engineers

CR - cultural resources

FWS - U.S. Fish and Wildlife Service

ITRAD - Industrial Technology Research and Development Center

KEDDO - Kiamichi Economic Development District

M#ft^3 - thousands of cubic feet

M&I - municipal and industrial

mi^2 - square miles

m.s.l. - mean sea level

NED - National Economic Development

NRHP - Nation Register of Historic Places

ODWC - Oklahoma Department of Wildlife Conservation

OESC - Oklahoma Employment Security Commission

OG&E - Oklahoma Gas and Electric Company

OSU - Oklahoma State University

OTRD - Oklahoma Tourism and Recreation Department

OWRB - Oklahoma Water Resources Board

RED - Regional Economic Development

RedArk - RedArk Development Authority

REDC - Rural Enterprise Development Corporation

RIDA - Regional Industrial Development Association

RV - recreational vehicle

SCORP - State Comprehensive Outdoor Recreation Plan

SEDIP - Successful Economic Development Initative Plans

SODA - Southern Oklahoma Development Association

SCS - Soil Conservation Service

T or E - threatened or endangered

TVA - Tennessee Valley Authority

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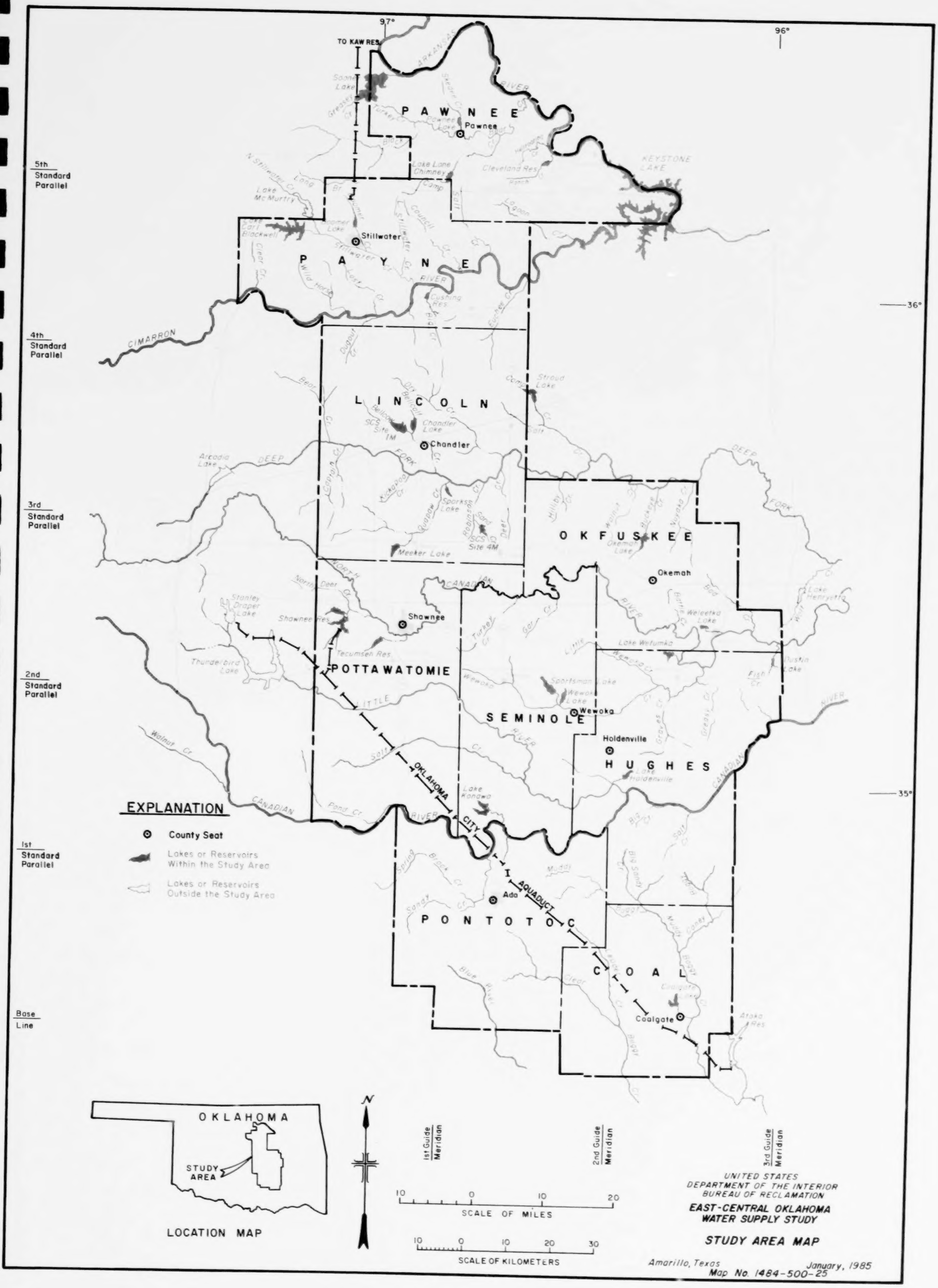
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Lake Cr
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Dry Cr
Bellcow Cr
SCS Site 1M
Chandler Lake
Stroud Lake
Camp Cr
Salt Cr
Arcadia Lake
DEEP FORK
Captain Cr
Kickapoo Cr
Sparks Lake
Quapaw Cr
Robinson Cr
Sand Cr
Deer Cr
SCS Site 4M
Meeker Lake
OKFUSKEE
Okemah
Okemah Lake
Hillby Cr
Walnut Cr
Buckeye Cr
Nuyaka Cr
Bad Cr
Lake Henryetta
Weleetka Lake
Wolf Cr
NORTH CANADIAN
Stanley Draper Lake
Shawnee Res
Shawnee
Tecumseh Res.
Thunderbird Lake
POTTAWATOMIE
Turkey Cr
Gar Cr
Wewoka Cr
Lake Wetumka
Sportsman Lake
Wewoka Lake
Wewoka
SEMINOLE
Holdenville
HUGHES
Lake Holdenville
Dustin Lake
Fish Cr
Graves Cr
LITTLE RIVER
Salt Cr
Walnut Cr
CANADIAN
Pond Cr
RIVER
Lake Konawa
OKLAHOMA CITY AQUADUCT
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Brock Cr
Muddy Cr
Sandy Cr
Big Cr
Big Sandy Cr
Salt Cr
Ada
PONTOTOC
Blue River
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Atoka Res
EXPLANATION
County Seat
Lakes or Reservoirs Within the Study Area
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OKLAHOMA
STUDY AREA
LOCATION MAP
N
1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
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SCALE OF MILES
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SCALE OF KILOMETERS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

STUDY AREA MAP

Amarillo, Texas January, 1985
Map No. 1484-500-25

CHAPTER I - INTRODUCTION

A. Description of the Study Area

1. Location

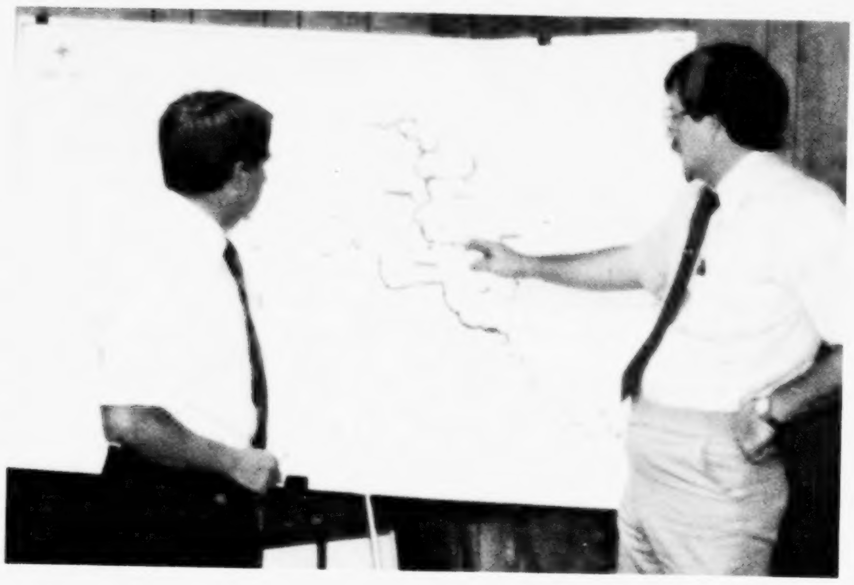
The nine-county study area is an elongated strip approximately 152 miles long and 66 miles wide located in east-central Oklahoma as shown in the frontispiece map No. 1484-500-25 (Study Area Map). Counties included are Coal, Hughes, Lincoln, Okfuskee, Pawnee, Payne, Pontotoc, Pottawatomie, and Seminole.

2. Characteristics

The study area has a land area of 6,298 square miles (mi^2) (9.2 percent of the State area), a 1980 census population of 251,160 (8.3 percent of the State population), and a population density of 39.9 persons per square mile compared to the State figure of 44.1. About 48.7 percent of the study area population is rural, compared to the State percentage of 32.7.

The study area climate is moist and subhumid to humid. Recorded temperature extremes have ranged from a minimum of -6° F to a maximum of 113° F, with average annual temperatures ranging from 60-63° F. Average annual precipitation in the study area ranges from 34 to 40 inches. May is usually the wettest month; and rainfall decreases through the summer until fall, the second wettest season. January ranks as the driest month.

Elevations in the study area range from 1,215 to 200 feet mean sea level (m.s.l.), with the higher elevations along the western edge gently sloping to the lowest elevations along the eastern and southern edges.



Harvey Bolinger, Executive Director of RedArk, explains a plan concept to Congressman Wes Watkins of the Third Oklahoma District.

The RedArk Water Resources Task Force engaged in one of the meetings that planned the work to be done in the East-Central Oklahoma Water Supply Study.

B. Background

On December 28, 1981, Congressman Wes Watkins (Third Congressional District of Oklahoma) convened a meeting of key representatives of several development agencies in Poteau, Oklahoma. The purpose of the meeting was to develop a general concensus on the economic development needs of southeastern Oklahoma and to devise a means to assess the region's economic potential, formulate plans of development, and implement developmental plan strategies. A study team was formed to conduct an orderly review of all resources in the area and a comprehensive assessment of their development potential.

RedArk Development Authority (RedArk) was established at McAlester as a State public trust with the overall responsibility of guiding the comprehensive assessment, coordinating the activities of the participating members, and implementing any development plans.

RedArk; the Central Oklahoma Economic Development District (COEDD) at Shawnee; the East-Central Water Association at McAlester, along with the Oklahoma Water Resources Board (OWRB); Governor George Nigh; and Congressman Wes Watkins sought and obtained the authorization and funding for the East-Central Oklahoma Water Supply Study, which was begun in October 1984.

McAlester, Oklahoma, is the headquarters for the RedArk Development Authority.

The RedArk logo is coming to be a familiar sign in the 24-county development area as a result of its many economic development initiatives.

In April 1984, prior to congressional enactment of authority and funding for this study, the OWRB requested that the Bureau of Reclamation (Reclamation) inventory available surface and ground water resources in east-central Oklahoma under its Technical Assistance to States Program. Reclamation agreed to prepare a limited (human and fiscal resources) inventory during the remaining 5 months of fiscal year 1984.

In July of 1984, the 4-year study for the east-central area was authorized and funded. This action made additional resources available to extend the inventory effort past September 1984 and enhanced the inventory effort by adding several more months of preliminary work or identification of problems and needs for the study area.

This planning guide report thus represents the results of 5 months' inventory work completed under the Technical Assistance to States Program and 3 months of problems and needs assessment under the east-central water supply study. In addition to meeting the commitment made to OWRB and RedArk in the spring of 1984, this document will provide supporting data to complement the East-Central Oklahoma Water Supply Study. This document will complement Reclamation's report to be completed at the end of the 4-year study.

C. Authority and Purpose of Study

1. Authority

This study was authorized by Public Law 98-360, dated July 16, 1984, entitled "Appropriation for Energy and Water Development for FY 1985."

2. Purpose

This study will address the maximum amount of economic development that can be achieved in the study area by water resource development. The results of the study will be used as a guide toward the most beneficial development of east-central Oklahoma water resources for municipal and industrial (M&I) water supply systems, hydroelectric power, navigation, irrigation, flood control, recreation, and environmental enhancement purposes. In order to do this, the study will focus on (1) assessment of the natural resources which have potential for development that can contribute to the national and regional economic development; (2) determination of what existing and potential water supplies are available or needed to facilitate regional development and which supplies might be available for needs outside the area; (3) formulation, analysis, and recommendation of a comprehensive plan of water resource development for each stage of future regional growth; and (4) identification of which projects or project components in the plan can be best developed by private, local, State, or Federal means.

D. Previous Investigations

Many of the water planning activities for the State are conducted by three Federal agencies--Reclamation, the Corps of Engineers (Corps), and the Soil Conservation Service (SCS). Table I-1 provides information on previous investigations that included the study area. The SCS has 26 watershed plans (Public Law 566) that involve the study area. They are not included in table I-1 but are discussed and displayed in Chapter IX, Water Resources.

E. Relationship of Study Area to Local Planning Districts and Regions

The study area includes all or portions of two Sub-State Economic Development Districts, four State water resource planning regions, and RedArk, as detailed in table I-2. Color maps Nos. 1484-500-26 through -29 display these relationships as well as how the study area relates to three of the State's congressional districts.

Table I-1
Previous Investigations
(East-Central Oklahoma Water Supply Study, January 1985, Revised March 85)

Title	Level of Study/Date	Agency	Conclusions
Central Oklahoma Project (Navigation)	Feasibility - 1964	Corps	Study investigated feasibility of extending navigation from the McClellan-Kern Navigation System into Eufaula Lake and then to Oklahoma City. Numerous routes were studied. The project was not economically justified.
Water, The Key to Oklahoma's Future	Appraisal - Oct 1966, Revised: Feb 1967	Reclamation	Water is available in the State to supply all needs for at least the next 100 years. The supply can be met by proper development of available surface and ground water resources and by redistribution of surface water available for this purpose.
Red River Below Denison Dam (Irrigation Development)	Appraisal - Part I - July 1966 Part II - Jan 1967	Reclamation	Part I - Conclusion that construction was economically justified at that time under conservative appraisals. Irrigation development on selected areas could be done by private interests or as a Federal project. Part II - Conclusion that areas meeting economic and financial requirements might be developed by local interests with private financing.
Oklahoma State Water Plan - Southwest 20 Counties	Appraisal - Jan 1975	Reclamation	The most technologically reasonable alternative for providing the bulk of water deficiency is redistribution of current supplies within the State.
Parker Lake (Red River Below Denison Dam)	Feasibility - Nov 1975	Corps	Project would develop the maximum dependable yield for the basin (42 Mgal/d) at the damsite. Water supply planned for use by Ada, Oklahoma, and other communities in central Oklahoma.
Tupelo Lake (Central Oklahoma Project)	Feasibility - Mar 1978	Corps	This project would function as a water supply source for the Central Oklahoma Project. Would produce a dependable yield of 90 Mgal/d to meet long-range needs.
Central Oklahoma Project (Water Conveyance)	Feasibility - 1978	Corps	Eleven alternative plans were studied to transfer surplus water from southeastern Oklahoma to meet future water needs in central and southwestern Oklahoma.
Oklahoma Comprehensive Water Plan	Comprehensive Study - Jan 1980	OWRB	Inadequate distribution systems are a statewide problem requiring immediate attention. There are adequate supplies of water, unevenly distributed. To meet projected water deficits of central and western Oklahoma, construction of a statewide water conveyance system consisting of a northern system for the Arkansas River Basin and a southern system for the Red River Basin should be considered.
Oklahoma State Water Plan - Phase I - Southern 33 Counties	Appraisal - Oct 1980	Reclamation	Presented a plan to redistribute surplus water to water-deficient areas through a major canal system in the Red River Basin.
Oklahoma State Water Plan - Phase II - Northern 44 Counties	Appraisal - Oct 1980	Reclamation	Presented a plan to redistribute surplus water to water-deficient areas through a major canal system in the Arkansas River Basin.
Resource Assessment and Development Strategies	Assessment - Oct 1982	Corps, Reclamation, SCS, and Tennessee Valley Authority (TVA)	The study area is rich in resources which have not been developed to their optimum potential. The study area is not homogeneous. Different areas contain different resources, problems, and opportunities. Different development strategies will need to be developed.
Water Supplies of Southeastern Oklahoma	July 1984	TVA	Studied 24-county area (southeast Oklahoma). Identified problems ranging from inadequately treated water storage to inadequate new water sources, from insufficient water pressures to insufficient funds, and from poor distribution to poor quality.
Wellston Lake (Central Oklahoma Project)	Feasibility	Corps	To provide navigation water releases for the Deep Fork route of the Central Oklahoma Project. Studies halted when navigation system proved economically infeasible.
Regional Water Distribution Investigation	Appraisal	Reclamation	To facilitate the efficient distribution of water from available sources to area of need. The study is continuing.
Parker Reservoir Central Oklahoma Pipeline Study	Subappraisal	Reclamation	A pipeline system (84 miles) would transport water from proposed Parker reservoir to Lake Thunderbird, Shawnee Reservoir, and Tecumseh Lake to aid in supplying municipal and industrial water needs in the central area system.

Table I-2

Local Planning Districts and Regions Involved With the Study Area

(East-Central Oklahoma Water Supply Study, January 1985)

Name and Location	Number of Counties Represented in Study Area	Name of Counties
Central Oklahoma Economic Development District - Headquarters: Shawnee	7	Hughes, Lincoln, Okfuskee, Pawnee, Payne, Pottawatomie, and Seminole
Southern Oklahoma Development Association - Headquarters: Ardmore	2	Coal and Pontotoc
North Central Water Resource Planning Region 1/	3	Lincoln, Pawnee, and Payne
Central Water Resource Planning Region 1/	1	Pottawatomie
East-Central Water Resource Planning Region 1/	3	Hughes, Okfuskee, and Seminole
Southeast Water Resource Planning Region 1/	2	Coal and Pontotoc
RedArk Development Authority - Headquarters: McAlester	9	Coal, Hughes, Lincoln, Okfuskee, Pawnee, Payne, Pontotoc, Pottawatomie, and Seminole

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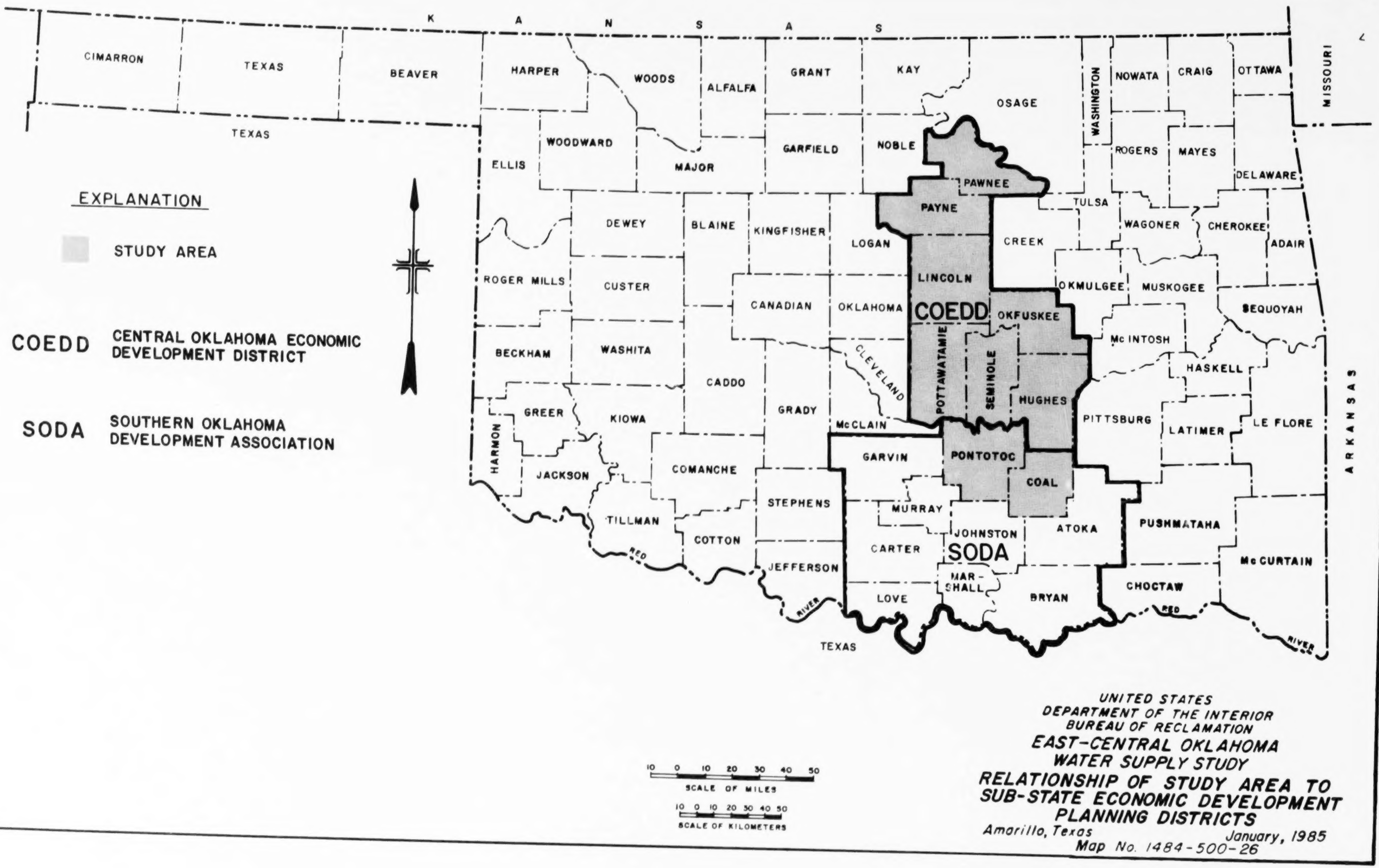
1/ Not distinct, organized entities. The Oklahoma Water Resources Board divided the State into convenient planning regions to facilitate work on the State Water Plan.


KANSAS
MISSOURI
ARKANSAS
TEXAS
TEXAS
RED RIVER
RED
RED RIVER
CIMARRON
TEXAS
BEAVER
HARPER
WOODS
ALFALFA
GRANT
KAY
OSAGE
WASHINGTON
NOWATA
CRAIG
OTTAWA
ELLIS
WOODWARD
MAJOR
GARFIELD
NOBLE
PAWNEE
ROGERS
MAYES
DELAWARE
PAYNE
TULSA
WAGONER
CHEROKEE
ADAIR
DEWEY
BLAINE
KINGFISHER
LOGAN
CREEK
ROGER MILLS
CUSTER
LINCOLN
OKMULGEE
MUSKOGEE
CANADIAN
OKLAHOMA
COEDD
OKFUSKEE
SEQUOYAH
McINTOSH
BECKHAM
WASHITA
CADDO
CLEVELAND
POTTAWATAMIE
SEMINOLE
HASKELL
HUGHES
PITTSBURG
LATIMER
LE FLORE
GREER
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GRADY
McCLAIN
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JACKSON
COMANCHE
GARVIN
PONTOTOC
COAL
STEPHENS
MURRAY
TILLMAN
JOHNSTON
ATOKA
PUSHMATAHA
COTTON
CARTER
SODA
McCURTAIN
JEFFERSON
MAR-SHALL
CHOCTAW
LOVE
BRYAN
EXPLANATION
STUDY AREA
COEDD CENTRAL OKLAHOMA ECONOMIC DEVELOPMENT DISTRICT
SODA SOUTHERN OKLAHOMA DEVELOPMENT ASSOCIATION
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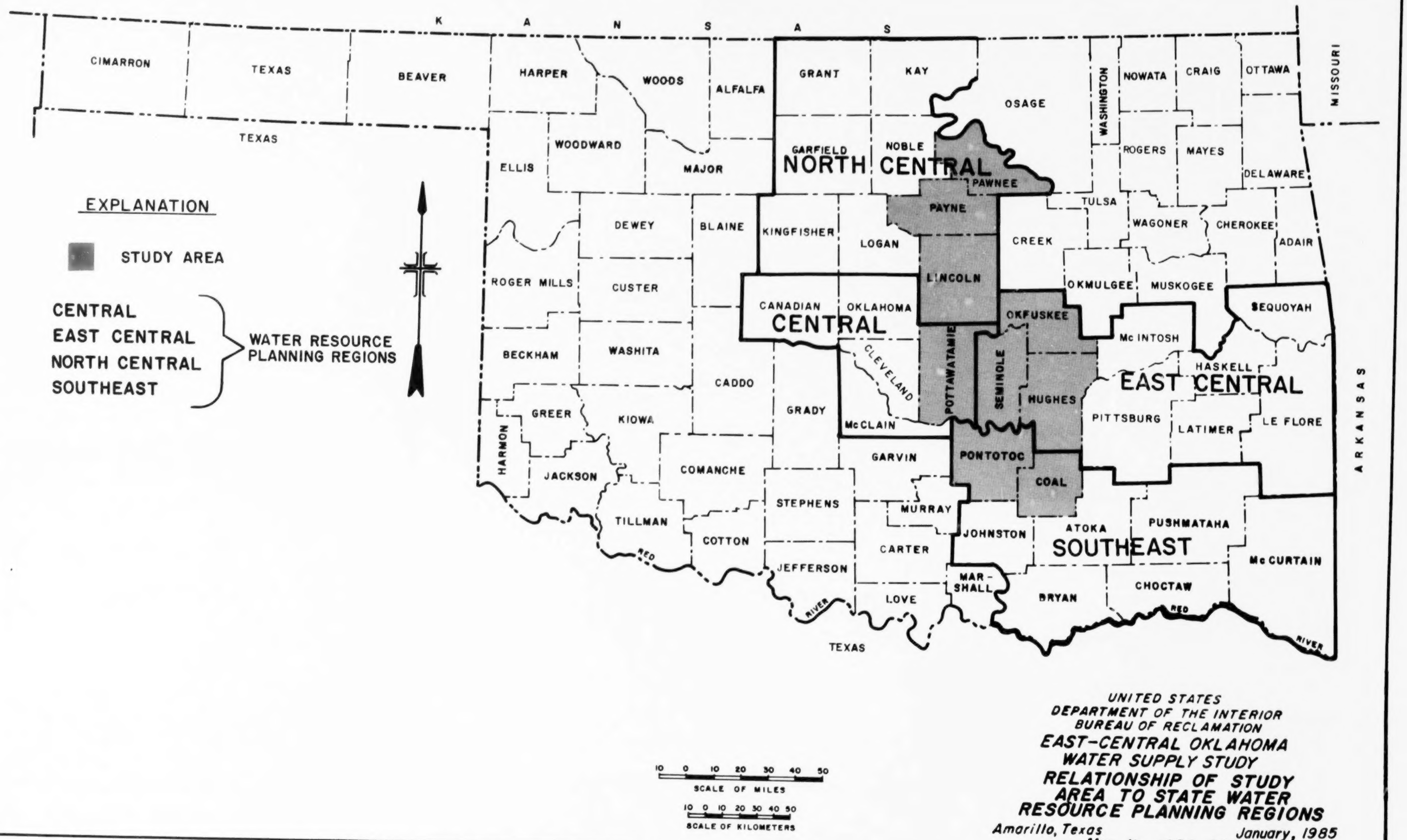
SCALE OF MILES
10 0 10 20 30 40 50
SCALE OF KILOMETERS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

RELATIONSHIP OF STUDY AREA TO SUB-STATE ECONOMIC DEVELOPMENT PLANNING DISTRICTS

Amarillo, Texas January, 1985
Map No. 1484-500-26



KANSAS
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ARKANSAS
TEXAS
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EXPLANATION
▨ STUDY AREA
CENTRAL
EAST CENTRAL
NORTH CENTRAL
SOUTHEAST
WATER RESOURCE PLANNING REGIONS
NORTH CENTRAL
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EAST CENTRAL
SOUTHEAST
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DELAWARE
DEWEY
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KINGFISHER
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CHEROKEE
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ROGER MILLS
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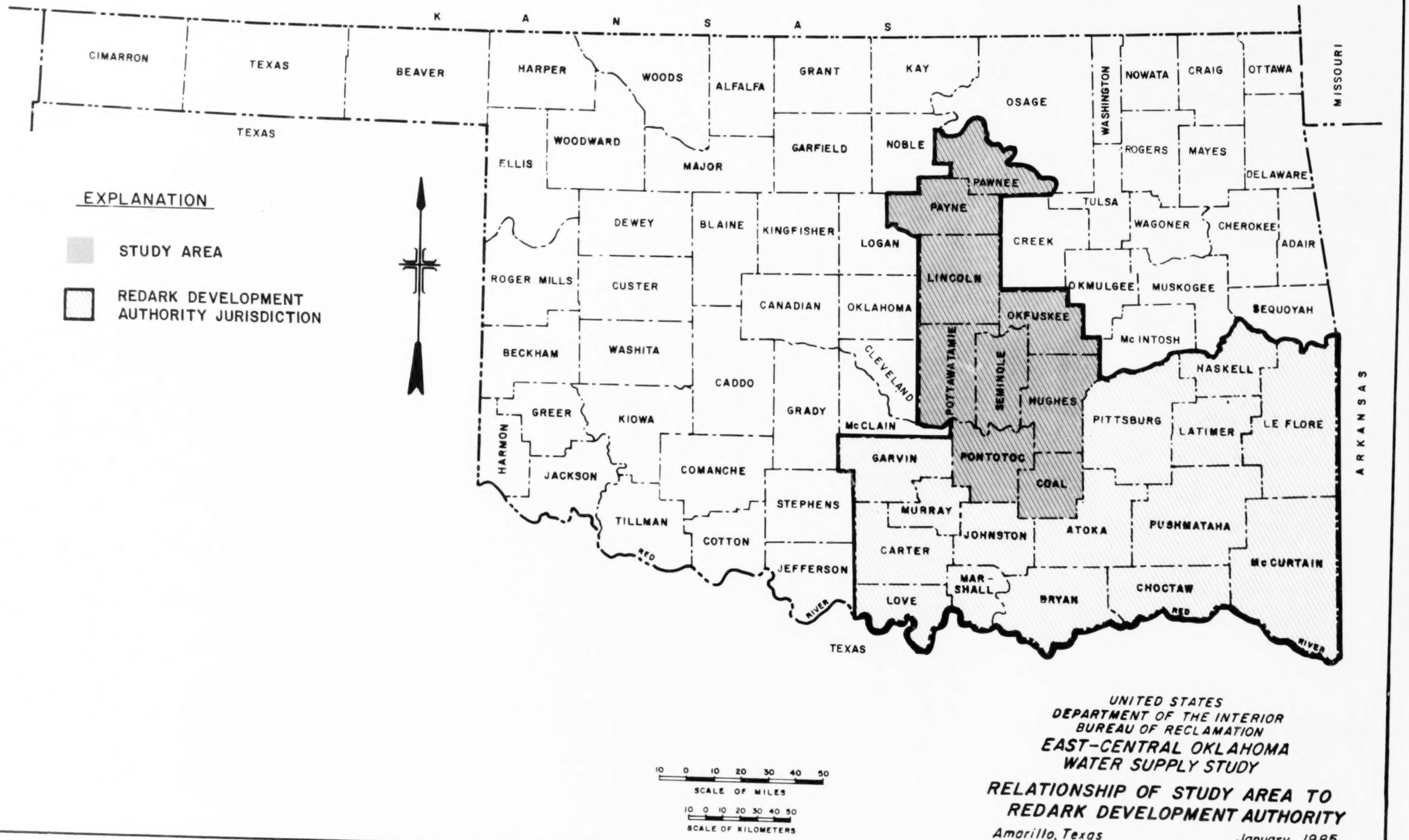
SCALE OF MILES
10 0 10 20 30 40 50
SCALE OF KILOMETERS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY
RELATIONSHIP OF STUDY
AREA TO STATE WATER
RESOURCE PLANNING REGIONS
Amarillo, Texas January, 1985
Map No. 1484-500-27


EXPLANATION
▨ STUDY AREA
▨ REDARK DEVELOPMENT AUTHORITY JURISDICTION
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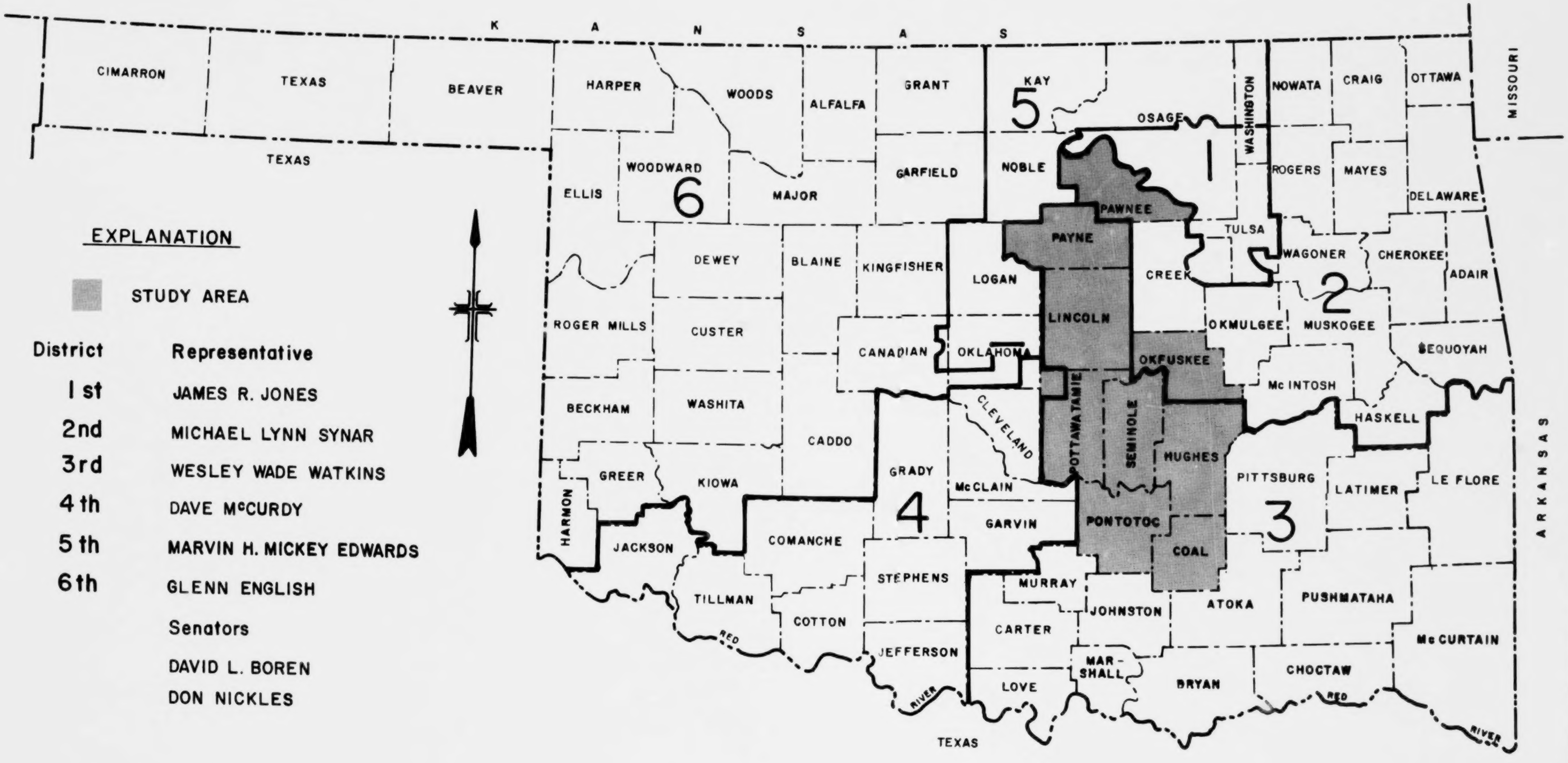
SCALE OF MILES
10 0 10 20 30 40 50
SCALE OF KILOMETERS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

RELATIONSHIP OF STUDY AREA TO REDARK DEVELOPMENT AUTHORITY

Amarillo, Texas January, 1985
Map No. 1484-500-28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KINGFISHER
LOGAN
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ADAIR
ROGER MILLS
CUSTER
CANADIAN
OKLAHOMA
LINCOLN
OKMULGEE
MUSKOGEE
SEQUOYAH
OKFUSKEE
McINTOSH
BECKHAM
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CLEVELAND
POTTAWATAMIE
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SCALE OF MILES
10 0 10 20 30 40 50
SCALE OF KILOMETERS

EXPLANATION

▨ STUDY AREA

District	Representative
1st	JAMES R. JONES
2nd	MICHAEL LYNN SYNAR
3rd	WESLEY WADE WATKINS
4th	DAVE McCURDY
5th	MARVIN H. MICKEY EDWARDS
6th	GLENN ENGLISH
	Senators
	DAVID L. BOREN
	DON NICKLES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

RELATIONSHIP OF STUDY AREA TO OKLAHOMA CONGRESSIONAL DISTRICTS

Amarillo, Texas *January, 1985*
Map No. 1484-500-29

CHAPTER II - HUMAN RESOURCES

A. Population Characteristics

The State of Oklahoma has experienced only modest population losses during two decades of the last 50 years. Whereas most of the counties have experienced 30 or 40 years of population losses out of the last 50 years as shown in table II-1.

Table II-1
Present Census and Historical Population Trends 1/
(East-Central Oklahoma Water Supply Study, January 1985)

Counties	1980 Population	Percent Change 1970 to 1980	1960 to 1970	1950 to 1960	1940 to 1950	1930 to 1940	Total Net Change 1930 - 1980
Coal	6,041	9.3	- 0.4	-31.2	-37.1	11.8	-47.6
Hughes	14,338	8.4	-12.7	-26.7	-29.2	- 3.8	-52.7
Lincoln	26,601	36.5	3.7	-15.0	-25.2	-12.5	-21.2
Okfuskee	11,125	4.1	- 8.7	-30.9	-35.5	- 9.4	-61.7
Pawnee	15,310	35.0	4.2	-20.1	-21.7	-12.5	-23.0
Payne	62,435	23.3	14.5	- 4.7	28.8	- 2.3	69.2
Pontotoc	32,598	17.0	- 0.8	- 9.0	-22.4	22.6	0.4
Pottawatomie	55,239	28.1	4.0	- 4.7	-20.0	-18.3	-17.0
Seminole	27,473	9.3	-10.4	-31.0	-33.5	-23.1	-65.5
State	3,025,290	18.2	9.9	4.3	- 4.4	- 2.5	26.3

1/ Source: U.S. Census 1980.

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The atypical, significant positive growth of Payne County over the past 50 years is probably due to the location of Oklahoma State University (OSU) in Stillwater, the county seat. The table also shows that three counties (Seminole, Okfuskee, and Hughes) lost over half of their population since 1930 and that Coal County has come close to doing so.

Table II-2 shows that the study area has a 3.1 percent smaller total minority representation than does the State. American Indians have greater proportional numbers than do Blacks in all of the study area except in Payne County. People of Spanish origin do not have sufficient numbers to be a major study area minority.

Table II-2
Percentage Analysis of Major Racial Composition of the Study Area 1/
(East-Central Oklahoma Water Supply Study, January 1985)

County	White	All Minorities 2/	Black	American Indian	Spanish Origin
Coal	86.7	13.3	1.0	11.9	0.8
Hughes	83.0	17.0	3.1	13.6	0.9
Lincoln	93.1	6.9	3.0	3.4	0.9
Okfuskee	72.1	27.9	12.5	14.6	0.5
Pawnee	92.1	7.9	1.0	6.5	0.6
Payne	91.6	8.4	3.0	2.5	1.6
Pontotoc	89.2	10.8	2.7	7.5	0.8
Pottawatomie	89.8	10.2	2.0	7.3	1.2
Seminole	78.1	21.9	7.9	13.5	0.8
Study area	88.1	11.9	3.5	7.1	1.1
State	85.0	15.0	6.7	5.6	0.9

1/ U.S. Census 1980.
2/ This number is not the sum of all minority percentages since the analysis does not list all "other" minorities, and some of Spanish origin are counted as White or Black in other analysis.

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In displaying urban-rural residence characteristics of the study area, table II-3 shows the contrast between the more urbanized Payne, Pottawatomie, and Seminole Counties and the more rural counties of Lincoln, Pawnee, and Coal, the latter of which is classified as 100-percent rural. In should be noted that the U.S. Census currently includes municipalities of 2,500 or less along with areas normally perceived as rural under the heading of "Rural." Most other areas fall under the "Urban" category. The significance of the relatively large number of study area residents living in small municipalities and on farmsteads will become more evident when the problems of trying to plan for adequate supplies of inexpensive, good quality water for rural residents are encountered.

Table II-3
Population of Study Area Counties by Urban and Rural Residence, 1980 1/
(East-Central Oklahoma Water Supply Study, January 1985)

County	Urban 2/ Total	Urban 2/ Percent	Rural Total	Rural Percent	Places of 1,000 to 2,500	Places of less than 1,000	Other Rural
Coal	-0-	--	6,041	100	2,001	1,198	2,842
Hughes	5,469	38.1	8,869	61.9	1,725	1,540	5,604
Lincoln	6,065	22.8	20,536	77.2	3,240	4,280	13,016
Okfuskee	3,381	30.4	7,744	69.6	1,195	1,001	5,548
Pawnee	2,972	19.4	12,338	80.6	1,688	2,681	7,969
Payne	45,988	73.7	16,447	26.3	3,414	953	12,080
Pontotoc	15,902	48.8	16,696	51.2	-0-	3,513	13,183
Pottawatomie	35,690	64.6	19,549	35.4	3,388	2,737	13,424
Seminole	14,070	51.2	13,403	48.8	2,081	1,450	9,872

1/ Source: U.S. Census 1980.

2/ None of the study area population falls under the "Inside Urbanized Areas" category. All study area urban populations are listed under the "Outside Urbanized Areas" category.

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B. Socioeconomic Characteristics

Congressman Wes Watkins, RedArk, the Southern Oklahoma Development Association (SODA), COEDD, and various State agencies have frequently pointed out that the study area is part of a region which has not benefited from economic development to the same degree as other regions of the State and Nation. Most frequently cited examples to illustrate this condition are higher than average unemployment rates, lower than average per capita incomes, and outmigration of the well-educated and trained young people seeking better economic opportunities. These conditions are said to create barriers that make it difficult to get the economic development that would solve many of the region's problems. Frequently mentioned barriers are somewhat overage, undereducated and undertrained work force; inadequate local and regional tax base to finance needed economic development components; over-reliance on earnings from nongrowth or declining economic sectors; etc. With these indicators to look for, the following textual and tabular description of socioeconomic characteristics is presented.

Although per capita income nearly doubled (75- to 90-percent increase) in the study area counties during the 5 years between 1977 and 1982, all remained significantly below the State and national figure as can be seen in table II-4. The fact that per capita income in two-thirds of the study area counties ranged from over 20 to nearly 40 percent below the State and national figure should be noted.

Table II-4
Comparison of 1977 and 1982 Per Capita Income for Study Area
(East-Central Oklahoma Water Supply Study, January 1985)

County	Per Capita Income 1977 1/	1982 1/	Compared to State - 1982	Increase 1977-1982	
Coal	$3,659	$ 6,946	38.2% less	$3,287	90% more
Hughes	$4,196	$ 7,863	30.1% less	$3,667	87% more
Lincoln	$5,058	$ 8,910	20.8% less	$3,852	76% more
Okfuskee	$3,927	$ 7,326	34.9% less	$3,399	87% more
Pawnee	$4,966	$ 8,838	21.4% less	$3,872	78% more
Payne	$4,951	$ 8,671	22.9% less	$3,720	75% more
Pontotoc	$5,431	$ 9,802	12.8% less	$4,371	80% more
Pottawatomie	$5,660	$10,022	10.9% less	$4,362	77% more
Seminole	$5,057	$ 9,542	15.2% less	$4,485	89% more
State	$6,306	$11,247		$4,941	78% more
United States	$6,984	$11,100		$4,116	59% more

1/ Source: Bureau of Economic Analysis, Regional Economic Information System. Estimates based on 1972 standard industrial code.

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Table II-5 displays 1982 earnings by industry sector for the study area. Analysis of the data in table II-5 provides a great deal of information about study area economic activity, which is summarized in Analysis of Table II-5, Summary Tabulations.

Table II-5
Study Area Earnings By Industry Sector: 1982 1/
East-Central Oklahoma Water Supply Study, January 1985
($1,000)

	Counties									Study Area	State	United States
	Coal	Hughes	Lincoln	Okfuskee	Pawnee	Payne	Pontotoc	Pottawatomie	Seminole			
Industry												
Farms	949	1,066	2,226	980	4,156	4,221	2,117	3,488	769	19,972	704,909	33,474,000
Nonfarm	14,034	42,876	83,088	36,398	51,687	368,396	203,135	286,112	171,232	1,256,958	24,834,591	1,793,161,000
Private	9,633	31,300	67,676	26,128	38,993	223,999	156,460	240,176	147,448	941,813	20,332,780	1,483,665,000
Agricultural services, forestry, fish, etc. 2/	175	679	309	3/	305	609	456	791	278	3,602 4/	74,241	7,469,000
Mining	774	10,055	10,848	7,493	7,980	25,913	21,793	28,258	65,697	178,811	3,397,322	37,268,000
Construction	674	1,326	5,479	3,458	4,395	19,692	10,633	22,349	5,074	73,080	1,375,632	96,583,000
Manufacturing 5/	2,327	3,463	11,522	3,581	1,469	49,018	34,905	54,861	19,038	180,184	4,248,408	445,930,000
Transportation and public utilities	749	2,335	5,719	3/	3,360	21,082	10,927	24,535	13,752	82,459 4/	2,010,769	144,658,000
Trade 6/	1,806	6,718	17,481	5,174	11,037	54,841	40,752	49,355	23,841	211,005	4,264,996	297,544,000
Finance insurance and real estate	413	1,860	6,597	1,373	2,058	11,583	7,175	13,721	6,205	50,985	1,239,993	112,520,000
Services	2,715	4,864	9,721	3,226	8,389	41,261	29,819	46,306	13,563	159,864	3,721,419	341,693,000
Public - U.S. Government and Government enterprises 7/	4,401	11,576	15,412	10,270	12,694	144,397	46,675	45,936	23,784	315,145	4,501,811	309,496,000

1/ Source: Bureau of Economic Analysis, Regional Economic Information System. Estimates based on 1972 standard industrial code.
2/ Includes fishing, hunting, trapping, and wages and salaries of United States residents working for international organizations in the United States.
3/ Not shown to avoid disclosure of confidential information. Estimates are included in totals.
4/ Estimate does not include Okfuskee County because data were not shown to avoid disclosure of confidential information. Estimates are included in totals.
5/ Includes nondurable and durable goods.
6/ Includes wholesale and retail trade.
7/ Includes Federal (civilian and military), State, and local. The estimates of military earnings reflect revisions which have not been made for earlier years.

Analysis of Table II-5, Summary Tabulation

SUMMARY ANALYSES

Relationship of Farm Earnings to Total

Area	Percentage of Total
Study area	1.6
State	2.8
Nation	1.8

Relationship of Private Sector Earnings to Nonfarm Totals

Area	Percentage of Nonfarm Totals
Study area	74.8
State	81.9
Nation	82.7

Relationship of Public Sector Earnings to Nonfarm Totals

Area	Percentage of Nonfarm Totals
Study area	25.1
State	18.1
Nation	17.3

COUNTY ANALYSES

County with greatest percentage of farm earnings

Pawnee (7.4%)

County with least percentage of farm earnings

Seminole (0.4%)

Counties having a private sector component exceeding the public sector component

Lincoln	(Trade)
Pottawatomie	(Manufacturing, trade, and services)
Seminole	(Mining and trade)

Counties where public sector component earnings exceed largest private sector component

Coal
Hughes
Okfuskee
Pawnee
Payne
Pontotoc

NOTE: Study area falls into this category.

Most Important Private Sector Components

Trade	Mining (including oil and gas)	Manufacturing	Services
Lincoln County	Hughes County	Pottawatomie County	Coal County
Pawnee County	Okfuskee County		
Payne County	Seminole County		
Pontotoc County			
Study area			

Oklahoma State University (middle right center of photo) located in Stillwater, is the State's land grant college. As such, it has a vital role in all phases of agriculture development.

Aerial photo of Ardmore, Oklahoma, which serves as the headquarters for the Southeast Oklahoma Development Association (SODA).

Data concerning the 1982 tax base for the study area is presented in the tabulation below. The tabulation shows that the study area as a whole has a tax base that is $590 per capita less than the State. In turn, three counties have a smaller per capita tax base than the study area. They are Hughes - $54 less, Payne - $246 less, and Pottowatomie - $421 less. Conversely, two study area counties have per capita tax bases greater than the State's. They are Pawnee - $27 greater; Coal - $746 greater.

Study Area Tax Base - 1982 1/
(East-Central Oklahoma Water Supply Study, January 1985)

County	1982 Net Assessed Valuations	Net Assessed Valuations (per capita)	Net Assessed Valuations (per square mile)
Coal	$ 20,744,193	$3,434	$ 39,893
Hughes	$ 29,300,121	$2,044	$ 36,398
Lincoln	$ 55,941,074	$2,103	$ 58,030
Okfuskee	$ 27,824,443	$2,501	$ 44,306
Pawnee	$ 41,562,994	$2,715	$ 75,432
Payne	$ 115,619,220	$1,852	$167,322
Pontotoc	$ 73,368,285	$2,251	$102,327
Pottawatomie	$ 92,633,803	$1,677	$118,306
Seminole	$ 69,885,792	$2,544	$109,367
Study area	$ 526,879,925	$2,098	$ 83,658
State	$8,132,285,225	$2,688	$118,451

1/ Source: Directory of Oklahoma: 1983-84, Oklahoma Department of Libraries.

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When net assessed valuations are analyzed on a per-square-mile basis for considerations like ability to build and maintain county roads, a somewhat different picture emerges. The study area has $34,793 less tax base per square mile than does the State. Five study area counties have per-square-mile tax bases that are less than the study area's. They are: Pawnee - $8,226 less, Lincoln - $25,628 less, Okfuskee - $39,352 less, Coal - $43,765 less, and Hughes - $47,260 less. Pottawatomie County's per-square-mile net-assessed valuation of $118,306 approximates the State's. Only Payne County exceeds the State by $48,871 per square mile, which is significantly greater.

The fact that the 1983 average annual unemployment rate for the study area was 9.6 percent, which was the same as the Nation's and only 0.5 percent greater than the State's, is true but quite misleading as shown in table II-6.

Table II-6
1983 Average Employment, Unemployment, and Labor Force Characteristics for Study Area 1/
(East-Central Oklahoma Water Supply Study, January 1985)

County	Employment	Unemployment	Labor Force	Unemployment Rate (Percent)
Coal	1,807	415	2,222	18.7
Hughes	4,791	1,173	5,964	19.7
Lincoln	9,652	1,367	11,019	12.4
Okfuskee	3,765	572	4,337	13.2
Pawnee	5,778	911	6,689	13.6
Payne	30,835	2,106	32,941	6.4
Pontotoc	14,869	1,381	16,250	8.5
Pottawatomie	29,537	2,396	31,933	7.5
Seminole	10,733	1,563	12,296	12.7
Study area	111,767	11,884	123,651	9.6
State	1,405,000	140,000	1,544,000	9.1
United States	100,834,000	10,717,000	111,550,000	9.6

1/ Sources: Employment Security Commission, Oklahoma City, Oklahoma, and U.S. Bureau of Labor Statistics, Dallas, Texas.

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As can be seen in table II-6, the three counties having the largest labor force populations also have the lowest unemployment rates, thus disguising the fact that two-thirds of the study area's counties have unemployment rates ranging from more than 12 to nearly 20 percent.

Table II-7 shows selected characteristics of the study area labor force. The median age data would seem to support the contention that outmigration of young people has resulted in a somewhat overaged work force in some counties. The labor force participation data would seem to indicate that some counties within the study area do not have a large potential labor force that could be tapped for large-scale economic development.

Table II-7
Selected Characteristics of Study Area Labor Force 1/
(East-Central Oklahoma Water Supply Study, January 1985)

County	Total Population	Median Age-Total Population	Labor Force (1983 average)	Labor Force - Participation Rate (Percentage)	Additional Employment Needed to Equal State Participate Rate
Coal	6,041	35.2	2,222	36.8	858
Hughes	14,338	38.4	5,964	41.6	3,384
Lincoln	26,601	32.5	11,019	41.4	2,254
Okfuskee	11,125	36.0	4,337	40.0	1,224
Pawnee	15,310	33.6	6,689	43.7	2,587
Payne	62,435	23.8	32,941	52.8	exceeds State
Pontotoc	32,598	32.2	16,250	49.8	391
Pottawatomie	55,239	31.6	31,933	57.8	exceeds State
Seminole	27,473	33.5	12,296	44.8	1,703
Study area	251,160	N/A	123,651	49.2	12,401
State	3,025,290	30.1	1,544,000	51.0	N/A
United States	26,545,805	30.0	111,550,000	49.2	N/A

1/ Sources: U.S. Census 1980, Oklahoma Employment Security Commission, and the U.S. Bureau of Labor Statistics.

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Questions have been raised in the past about whether the study area population has reached an adequate level of educational development to be readily trainable in new high-technology skills needed if economic development initiatives are to succeed in attracting new businesses and industries. Table II-8 displays selected educational statistics that appear to indicate that the study area has a smaller percentage of high school graduates than the State or Nation. Although Payne County exceeds the State and Nation by over 8 percent, the remaining eight counties have 5-percent to over 40-percent fewer high school graduates.

Table II-8
Selected Education Statistics for the Study Area, 1980 1/
(East-Central Oklahoma Water Supply Study, January 1985)

County	Persons 25+ With at Least a High School Education (Percent)	Persons 25+ With Less Than 5 Years of Elementary School (Percent)	Median School Years Completed of Person 25+ (Percent)
Coal	42.6	8.2	10.7
Hughes	47.0	6.7	11.6
Lincoln	57.7	2.7	12.2
Okfuskee	46.4	8.5	11.5
Pawnee	61.5	2.5	12.3
Payne	74.6	1.8	12.8
Pontotoc	58.8	4.2	12.3
Pottawatomie	61.8	3.0	12.3
Seminole	54.7	4.8	12.1
State	66.0	3.1	12.5
United States	66.5	3.6	12.5

1/ Sources: Bureau of the Census - 1980 Census of Population, Volume I, Characteristics of the Population, General Social and Economic Characteristics, Oklahoma and United States.

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C. Population Projections

Any long-range planning and development effort needs to project what the future would be like if (1) long-range development objectives actually came to be as planned and (2) nothing were done and things continued on much as they had been. Part of this process of forecasting the future with and without the proposed economic development involves making population projections to determine an infinite number of future needs such as how much additional housing will be needed, how many more classrooms will be needed, or will the hospitals be large enough? This particular study will need to determine such things as how much additional water supply will be needed and where, what will the future needs for flood control be, how much need will there be for hydroelectric power, or what sort of water-based recreational facilities will people need 50 years from now?

Ten population projection tables follow. Table II-9 is the summary table for the study area. Tables II-10 through II-18 present detailed population projections for each study area county, in alphabetical order. Drawings Nos. 1484-500-30, -31, and -32 present a less complex graphic portrayal of the study area summary in table II-9. Each table provides projections for each decade from the year 1990 through the year 2040. Each decade on every table will compare two population projections labeled SEDIP (Successful Economic Development Initative Plans) and OESC (Oklahoma Employment Security Commission). The SEDIP projections show the population forecast for conditions resulting from successful regional economic development initiatives, while the OESC projections forecast the future population resulting from regional conditions going much as they have been.

The Corps' projections shown in tables II-9 through II-18 are only preliminary; therefore, they may be updated after more detailed studies have been completed.

D. Problems and Needs

Reclamation's mission is not primarily in the area of education or social welfare even though Reclamation has a long historic involvement in developing and teaching improved methods of irrigation management and in widely recognized successful management of Job Corps programs. However, human resource problems and needs must be listed and recognized for two reasons. First, it is impossible to develop alternative plans for long-range water resource development without recognizing and taking these problems and needs into account, because they function as constraints on the future as long as they are unmet. Second, meeting these problems and needs will put demands on the public sector human and financial resources just like every other component in any long-range, overall economic development plan. Meeting these human resource problems and needs will require tradeoff or allocation of resources decisions during the entire course of establishing and achieving a long-range economic development plan. Human resource problems and needs briefly touched upon in this chapter are summarized as follows:

1. Per capita income in the study area is significantly below State and national levels.

2. Private sector economic activity is limited in much of the study area, resulting in public sector payrolls (local, State, and Federal government) providing more earnings in six out of nine counties than any single private sector component such as trade, manufacturing, mining (including extraction of oil and gas), and services.

3. Much of the study area has unemployment rates significantly higher than the State or Nation.

4. Lack of economic opportunity has resulted in long-term outmigration in much of the study area, which has resulted in more than a 50-percent population loss in some cases.

5. The better educated young people with current high-technology job skills training needed for economic development initiatives are the very people leaving the study area.

6. The remaining local labor force appears to be somewhat older with less formal education than State and national norms.

7. Some counties in the study area appear to be very limited in additional labor force potential that might be needed for economic development initiatives.

8. There appears to be a very limited tax base to finance all components of a comprehensive long-range development plan.

9. Population projections show that continuation of historic and present trends (OESC projections) will result in the continued decline of some of the study area counties and stagnation or eventual decline for many communities during the next 50 years.

10. The SEDIP population projections show that a sustained, 50-year coordinated economic development effort by study area communities, interest groups, counties, economic development planning districts, and RedArk could result in healthy growth of the region. This growth could alleviate many of the problems and provide the study area with an opportunity to participate equally with the rest of the State in future prosperity.

11. Problems and needs listed above clearly indicate conditions associated with significant economic underdevelopment and validates the need for comprehensive economic development for the study area.

12. Further analyses need to be undertaken to determine whether the study area's socioeconomic problems would support a request for authority to formulate plans of development for Regional Economic Development (RED) objectives instead of the normally required formulations for National Economic Development (NED) objectives.

Table II-9

Summary of Comparative Population Projections for Study Area 1/

(East-Central Oklahoma Water Supply Study, January 1985)

Study Area - Counties	Year 1990 SEDIP 2/ Projections	Year 1990 OESC 3/ Projections	Year 2000 SEDIP Projections	Year 2000 OESC Projections	Year 2010 SEDIP Projections	Year 2010 OESC Projections	Year 2020 SEDIP Projections	Year 2020 OESC Projections	Year 2030 SEDIP Projections	Year 2030 OESC Projections	Year 2040 SEDIP Projections	Year 2040 OESC Projections
Coal	6,500	6,100	6,900	6,000	7,300	5,800	7,700	5,600	8,000	5,200	8,300	4,800
Cities	(3,780)	(3,550)	(4,260)	(3,700)	(4,780)	(3,800)	(5,380)	(3,900)	(5,930)	(3,850)	(6,580)	(3,800)
Balance of County	(2,720)	(2,550)	(2,640)	(2,300)	(2,520)	(2,000)	(2,320)	(1,700)	(2,070)	(1,350)	(1,720)	(1,000)
Hughes	15,400	14,000	16,400	13,000	17,300	11,900	18,100	10,600	18,800	9,200	19,400	7,900
Cities	(9,750)	(8,850)	(10,790)	(8,550)	(11,700)	(8,050)	(12,650)	(7,400)	(13,490)	(6,600)	(14,260)	(5,800)
Balance of County	(5,650)	(5,150)	(5,610)	(4,450)	(5,600)	(3,850)	(5,450)	(3,200)	(5,310)	(2,600)	(5,140)	(2,100)
Lincoln	33,700	32,500	40,100	36,800	45,900	41,000	51,100	44,500	55,800	47,000	60,000	49,200
Cities	(16,700)	(16,100)	(19,830)	(18,200)	(22,740)	(20,300)	(25,600)	(22,300)	(28,390)	(23,900)	(31,090)	(25,500)
Balance of County	(17,000)	(16,400)	(20,270)	(18,600)	(23,160)	(20,700)	(25,500)	(22,200)	(27,410)	(23,100)	(28,910)	(23,700)
Okfuskee	11,500	10,800	11,900	10,000	12,200	9,200	12,500	8,300	12,800	7,400	13,000	6,600
Cities	(6,230)	(5,850)	(6,850)	(5,750)	(7,690)	(5,800)	(8,500)	(5,650)	(9,600)	(5,550)	(10,840)	(5,500)
Balance of County	(5,270)	(4,950)	(5,050)	(4,250)	(4,510)	(3,400)	(4,000)	(2,650)	(3,200)	(1,850)	(2,160)	(1,100)
Pawnee	19,300	17,900	22,900	20,100	26,100	22,300	29,000	24,400	31,600	26,100	34,000	27,600
Cities	(8,300)	(7,700)	(8,780)	(7,700)	(9,070)	(7,750)	(9,310)	(7,820)	(9,380)	(7,750)	(9,460)	(7,680)
Balance of County	(11,000)	(10,200)	(14,120)	(12,400)	(17,030)	(14,550)	(19,690)	(16,580)	(22,220)	(18,350)	(24,540)	(19,920)
Payne	74,200	70,700	84,800	76,300	94,400	81,000	103,000	83,800	110,700	84,700	117,700	85,500
Cities	(60,140)	(57,300)	(69,230)	(62,300)	(77,740)	(66,700)	(85,810)	(69,800)	(93,380)	(71,450)	(100,630)	(73,100)
Balance of County	(14,060)	(13,400)	(15,570)	(14,000)	(16,660)	(14,300)	(17,190)	(14,000)	(17,320)	(13,250)	(17,070)	(12,400)
Pontotoc	37,300	35,200	41,500	36,200	45,300	36,800	48,700	36,500	51,800	35,300	54,600	34,200
Cities	(22,240)	(21,000)	(25,150)	(21,950)	(27,880)	(22,650)	(30,670)	(23,000)	(34,270)	(23,350)	(37,850)	(23,700)
Balance of County	(15,060)	(14,200)	(16,350)	(14,250)	(17,420)	(14,150)	(18,030)	(13,500)	(17,530)	(11,950)	(16,750)	(10,500)
Pottawatomie	67,300	63,100	78,200	68,500	88,000	73,200	96,800	76,300	104,700	77,300	111,800	78,300
Cities	(50,880)	(47,700)	(58,870)	(51,551)	(66,230)	(55,100)	(73,630)	(58,050)	(82,150)	(60,650)	(90,320)	(63,250)
Balance of County	(16,420)	(15,400)	(19,330)	(16,949)	(21,770)	(18,100)	(23,170)	(18,250)	(22,550)	(16,650)	(21,480)	(15,050)
Seminole	26,800	28,100	28,900	27,400	30,800	26,300	32,500	24,600	34,000	22,300	35,400	20,200
Cities	(17,770)	(18,650)	(19,880)	(18,850)	(21,730)	(18,550)	(23,780)	(18,000)	(26,670)	(17,500)	(29,790)	(17,000)
Balance of County	(9,030)	(9,450)	(9,020)	(8,550)	(9,070)	(7,750)	(8,720)	(6,600)	(7,330)	(4,800)	(5,610)	(3,200)

1/ Source: Corps of Engineers, data sheets, December 1984.

2/ SEDIP = Successful Economic Development Initiative Plans.

3/ OESC = Oklahoma Employment Security Commission.

Table II-10

Detailed Comparative Population Projections for Coal County [1/]

(East-Central Oklahoma Water Supply Study, January 1985)

Coal County	Year 1990		Year 2000		Year 2010		Year 2020		Year 2030		Year 2040	
	SEDIP [2/] Projections	OESC [3/] Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections
Bromide (part)	50	50	0	0	0	0	0	0	0	0	0	0
Centrahoma	210	200	230	200	250	200	280	200	310	200	350	200
Coalgate	2,290	2,150	2,530	2,200	2,770	2,200	2,960	2,150	3,080	2,000	3,200	1,850
Lehigh	270	250	290	250	250	200	280	200	230	150	170	100
Phillips	270	250	290	250	380	300	480	350	620	400	780	450
Tupelo	690	650	920	800	1,130	900	1,380	1,000	1,690	1,100	2,080	1,200
City Subtotal	3,780	3,550	4,260	3,700	4,780	3,800	5,380	3,900	5,930	3,850	6,580	3,800
Balance of County	2,720	2,550	2,640	2,300	2,520	2,000	2,320	1,700	2,070	1,350	1,720	1,000
County Total	6,500	6,100	6,900	6,000	7,300	5,800	7,700	5,600	8,000	5,200	8,300	4,800

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ SEDIP = Successful Economic Development Initiative Plans.
3/ OESC = Oklahoma Employment Security Commission.

Table II-11
Detailed Comparative Population Projections for Hughes County 1/
(East-Central Oklahoma Water Supply Study, January 1985)

Hughes County	Year 1990		Year 2000		Year 2010		Year 2020		Year 2030		Year 2040	
	SEDIP 2/ Projections	OESC 3/ Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections
Allen (part)	110	100	190	150	220	150	340	200	410	200	490	200
Calvin	330	300	320	250	360	250	340	200	310	150	250	100
Dustin	550	500	630	500	650	450	770	450	820	400	860	350
Gerty	170	150	190	150	220	150	260	150	310	150	370	150
Holdenville	6,160	5,600	6,810	5,400	7,410	5,100	8,030	4,700	8,580	4,200	9,090	3,700
Lamar	110	100	130	100	150	100	90	50	100	50	120	50
Stuart	280	250	250	200	290	200	260	150	310	150	370	150
Wetumka	1,870	1,700	2,080	1,650	2,180	1,500	2,390	1,400	2,450	1,200	2,460	1,000
Yeager	170	150	190	150	220	150	170	100	200	100	250	100
City Subtotal	9,750	8,850	10,790	8,550	11,700	8,050	12,650	7,400	13,490	6,600	14,260	5,800
Balance of County	5,650	5,150	5,610	4,450	5,600	3,850	5,450	3,200	5,310	2,600	5,140	2,100
County Total	15,400	14,000	16,400	13,000	17,300	11,900	18,100	10,600	18,800	9,200	19,400	7,900

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ SEDIP = Successful Economic Development Initiative Plans.
3/ OESC = Oklahoma Employment Security Commission.

Table II-12

Detailed Comparative Population Projections for Lincoln County [1]

(East-Central Oklahoma Water Supply Study, January 1985)

Lincoln County	Year 1990		Year 2000		Year 2010		Year 2020		Year 2030		Year 2040	
	SEDIP [2] Projections	OESC [3] Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections
Agra	410	400	490	450	500	450	570	500	590	500	610	500
Carney	830	800	1,140	1,050	1,400	1,250	1,720	1,500	2,080	1,750	2,440	2,000
Chandler	3,320	3,200	3,600	3,300	3,810	3,400	3,900	3,400	4,040	3,400	4,150	3,400
Devenport	1,140	1,100	1,250	1,150	1,290	1,150	1,320	1,150	1,370	1,150	1,400	1,150
Fallis	0	*	0	*	0	*	0	*	0	*	0	0
Kendrick	160	150	110	100	110	100	110	100	120	100	120	100
Meeker	1,350	1,300	1,740	1,600	2,130	1,900	2,530	2,200	2,850	2,400	3,170	2,600
Prague	2,800	2,700	3,270	3,000	3,810	3,400	4,250	3,700	4,750	4,000	5,240	4,300
Sparks	1,140	1,100	1,580	1,450	2,130	1,900	2,810	2,450	3,560	3,000	4,330	3,550
Stroud (part)	3,840	3,700	4,580	4,200	5,260	4,700	5,860	5,100	6,290	5,300	6,710	5,500
Tryon	570	550	760	700	900	800	1,090	950	1,250	1,050	1,400	1,150
Warwick	210	200	220	200	220	200	230	200	240	200	240	200
Wellston	930	900	1,090	1,000	1,180	1,050	1,210	1,050	1,250	1,050	1,280	1,050
City Subtotal	16,700	16,100	19,830	18,200	22,740	20,300	25,600	22,300	28,390	23,900	31,090	25,500
Balance of County	17,000	16,400	20,270	18,600	23,160	20,700	25,500	22,200	27,410	23,100	28,910	23,700
County Total	33,700	32,500	40,100	36,800	45,900	41,000	51,100	44,500	55,800	47,000	60,000	49,200

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[1] Source: Corps of Engineers, data sheets, December 1984.

[2] SEDIP = Successful Economic Development Initiative Plans.

[3] OESC = Oklahoma Employment Security Commission.

* The area contained less than 25 persons.

Table II-13
Detailed Comparative Population Projections for Okfuskee County [1]
(East-Central Oklahoma Water Supply Study, January 1985)

Okfuskee County	Year 1990 SEDIP [2] Projections	Year 1990 OESC [3] Projections	Year 2000 SEDIP Projections	Year 2000 OESC Projections	Year 2010 SEDIP Projections	Year 2010 OESC Projections	Year 2020 SEDIP Projections	Year 2020 OESC Projections	Year 2030 SEDIP Projections	Year 2030 OESC Projections	Year 2040 SEDIP Projections	Year 2040 OESC Projections
Boley	430	400	360	300	330	250	300	200	350	200	390	200
Castle	160	150	120	100	130	100	150	100	170	100	200	100
Okemah	3,940	3,700	4,640	3,900	5,300	4,000	6,170	4,100	7,090	4,100	8,080	4,100
Paden	480	450	540	450	600	450	600	400	690	400	790	400
Weleetka	1,220	1,150	1,190	1,000	1,330	1,000	1,280	850	1,300	750	1,380	700
City Subtotal	6,230	5,850	6,850	5,750	7,690	5,800	8,500	5,650	9,600	5,550	10,840	5,500
Balance of County	5,270	4,950	5,050	4,250	4,510	3,400	4,000	2,650	3,200	1,850	2,160	1,100
County Total	11,500	10,800	11,900	10,000	12,200	9,200	12,500	8,300	12,800	7,400	13,000	6,600

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[1] Source: Corps of Engineers, data sheets, December 1984.
[2] SEDIP = Successful Economic Development Initiative Plans.
[3] OESC = Oklahoma Employment Security Commission.

Table II-14

Detailed Comparative Population Projections for Pawnee County 1/

(East-Central Oklahoma Water Supply Study, January 1985)

Pawnee County	Year 1990		Year 2000		Year 2010		Year 2020		Year 2030		Year 2040	
	SEDIP 2/ Projections	OESC 3/ Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections
Blackburn	110	100	110	100	120	100	120	100	120	100	120	100
Bough	0	*	0	*	0	*	0	*	0	*	0	0
Calida	0	*	0	*	0	*	0	*	0	*	0	0
Cleveland	.3,560	3,300	3,990	3,500	4,330	3,700	4,520	3,800	4,720	3,900	4,930	4,000
Cuchee	0	*	0	*	0	*	0	*	0	*	0	0
Empy	0	*	0	*	0	*	0	*	0	*	0	0
Hallett	270	250	280	250	350	300	420	350	420	350	430	350
Jennings	380	350	400	350	410	350	360	300	360	300	370	300
Leander	0	*	0	*	0	*	0	*	0	*	0	0
Leroy	0	*	0	*	0	*	0	*	0	*	0	0
Maramec	110	100	60	50	60	50	60	50	60	50	60	50
Oak Grove	750	700	800	700	760	650	800	670	730	600	650	530
Pawnee	1,670	1,550	1,480	1,300	1,290	1,100	1,070	900	850	700	620	500
Peterman Ridge	0	*	0	*	0	*	0	*	0	*	0	0
Quay (part)	50	50	60	50	60	50	60	50	60	50	60	50
Rabornville	0	*	0	*	0	*	0	*	0	*	0	0
Ralston	590	550	630	550	640	550	650	550	670	550	680	550
Rigsby	50	50	60	50	60	50	60	50	60	50	60	50
Shady Grove	0	*	0	*	0	*	0	*	0	*	0	0
Sha-To-She	0	*	0	*	0	*	0	*	0	*	0	0
Skedee	110	100	110	100	60	50	60	50	60	50	60	50
Terlton	220	200	230	200	230	200	300	250	300	250	310	250
Timberlane	0	*	0	*	0	*	0	*	0	*	0	0
Wes	50	50	60	50	60	50	60	50	60	50	60	50
Westport	380	350	510	450	640	550	770	650	910	750	1,050	850
City Subtotal	8,300	7,700	8,780	7,700	9,070	7,750	9,310	7,820	9,380	7,750	9,460	7,680
Balance of County	11,000	10,200	14,120	12,400	17,030	14,550	19,690	16,580	22,220	18,350	24,540	19,920
County Total	19,300	17,900	22,900	20,100	26,100	22,300	29,000	24,400	31,600	26,100	34,000	27,600

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ SEDIP = Successful Economic Development Initiative Plans.
3/ OESC = Oklahoma Employment Security Commission.
* The area contained less than 25 persons.

Table II-15

Detailed Comparative Population Projections for Payne County [1]

(East-Central Oklahoma Water Supply Study, January 1985)

Payne County	Year 1990 SEDIP [2] Projections	Year 1990 OESC [3] Projections	Year 2000 SEDIP Projections	Year 2000 OESC Projections	Year 2010 SEDIP Projections	Year 2010 OESC Projections	Year 2020 SEDIP Projections	Year 2020 OESC Projections	Year 2030 SEDIP Projections	Year 2030 OESC Projections	Year 2040 SEDIP Projections	Year 2040 OESC Projections
Cushing	8,290	7,900	8,670	7,800	8,860	7,600	9,100	7,400	9,410	7,200	9,640	7,000
Drumright (part)	0	*	0	*	0	*	0	*	0	*	0	0
Glencoe	630	600	830	750	990	850	1,170	950	1,370	1,050	1,580	1,150
Perkins	2,470	2,350	3,220	2,900	4,200	3,600	5,290	4,300	6,530	5,000	7,850	5,700
Quay (part)	0	*	0	*	0	*	0	*	0	*	0	0
Ripley	580	550	720	650	930	800	1,110	900	1,310	1,000	1,510	1,100
Stillwater	46,180	44,000	53,460	48,100	60,140	51,600	66,250	53,900	71,620	54,800	76,680	55,700
Yale	1,990	1,900	2,330	2,100	2,620	2,250	2,890	2,350	3,140	2,400	3,370	2,450
City Subtotal	60,140	57,300	69,230	62,300	77,740	66,700	85,810	69,800	93,380	71,450	100,630	73,100
Balance of County	14,060	13,400	15,570	14,000	16,660	14,300	17,190	14,000	17,320	13,250	17,070	12,400
County Total	74,200	70,700	84,800	76,300	94,400	81,000	103,000	83,800	110,700	84,700	117,700	85,500

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ SEDIP = Successful Economic Development Initiative Plans.
3/ OESC = Oklahoma Employment Security Commission.
* The area contained less than 25 persons.

Table II-16
Detailed Comparative Population Projections for Pontotoc County [1]
(East-Central Oklahoma Water Supply Study, January 1985)

Pontotoc County	Year 1990 SEDIP [2] Projections	Year 1990 OESC [3] Projections	Year 2000 SEDIP Projections	Year 2000 OESC Projections	Year 2010 SEDIP Projections	Year 2010 OESC Projections	Year 2020 SEDIP Projections	Year 2020 OESC Projections	Year 2030 SEDIP Projections	Year 2030 OESC Projections	Year 2040 SEDIP Projections	Year 2040 OESC Projections
Ada	18,010	17,000	20,060	17,500	21,910	17,800	23,880	17,900	26,410	18,000	28,900	18,100
Allen (part)	950	900	970	850	980	800	1,000	750	1,100	750	1,200	750
Byng	1,270	1,200	1,830	1,600	2,460	2,000	3,200	2,400	3,820	2,600	4,470	2,800
Francis	420	400	520	450	620	500	730	550	880	600	1,040	650
Roff	850	800	970	850	1,050	850	930	700	1,030	700	1,120	700
Stonewall	740	700	800	700	860	700	930	700	1,030	700	1,120	700
City Subtotal	22,240	21,000	25,150	21,950	27,880	22,650	30,670	23,000	34,270	23,350	37,850	23,700
Balance of County	15,060	14,200	16,350	14,250	17,420	14,150	18,030	13,500	17,530	11,950	16,750	10,500
County Total	37,300	35,200	41,500	36,200	45,300	36,800	48,700	36,500	51,800	35,300	54,600	34,200

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ SEDIP = Successful Economic Development Initiative Plans.
3/ OESC = Oklahoma Employment Security Commission.

Table II-17
Detailed Comparative Population Projections for Pottawatomie County [1]
(East-Central Oklahoma Water Supply Study, January 1985)

Pottawatomie County	Year 1990		Year 2000		Year 2010		Year 2020		Year 2030		Year 2040	
	SEDIP [2] Projections	OESC [3] Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections
Asher	910	850	1,200	1,050	1,560	1,300	1,900	1,500	2,300	1,700	2,710	1,900
Bethel Acres	3,200	3,000	4,230	3,701	5,410	4,500	6,600	5,200	8,130	6,000	9,710	6,800
Brooksville	50	50	60	50	60	50	60	50	70	50	70	50
Earlsboro	270	250	290	250	300	250	250	200	270	200	290	200
McCloud	5,330	5,000	6,740	5,900	8,170	6,800	9,640	7,600	11,380	8,400	13,140	9,200
McComb	50	50	60	50	60	50	60	50	70	50	70	50
Maud (part)	1,280	1,200	1,430	1,250	1,560	1,300	1,650	1,300	1,760	1,300	1,860	1,300
Oklahoma City (part)	110	100	110	100	120	100	130	100	140	100	140	100
Pink	1,170	1,100	1,480	1,300	1,800	1,500	2,160	1,700	2,440	1,800	2,710	1,900
Remus	160	150	170	150	180	150	190	150	200	150	210	150
St. Louis	160	150	170	150	240	200	250	200	270	200	290	200
Shawnee	30,930	29,000	34,480	30,200	37,150	30,900	39,960	31,500	43,340	32,000	46,400	32,500
Tecumseh	6,400	6,000	7,530	6,600	8,660	7,200	9,770	7,700	10,700	7,900	11,570	8,100
Tribbey	270	250	290	250	240	200	250	200	270	200	290	200
Wanette	590	550	630	550	720	600	760	600	810	600	860	600
City Subtotal	50,880	47,700	58,870	51,551	66,230	55,100	73,630	58,050	82,150	60,650	90,320	63,250
Balance of County	16,420	15,400	19,330	16,949	21,770	18,100	23,170	18,250	22,550	16,650	21,480	15,050
County Total	67,300	63,100	78,200	68,500	88,000	73,200	96,800	76,300	104,700	77,300	111,800	78,300

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[1] Source: Corps of Engineers, data sheets, December 1984.
[2] SEDIP = Successful Economic Development Initiative Plans.
[3] OESC = Oklahoma Employment Security Commission.

Table II-18

Detailed Comparative Population Projections for Seminole County 1/

(East-Central Oklahoma Water Supply Study, January 1985)

Seminole County	Year 1990		Year 2000		Year 2010		Year 2020		Year 2030		Year 2040	
	SEDIP 2/ Projections	OESC 3/ Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections	SEDIP Projections	OESC Projections
Bowlegs	520	550	580	550	640	550	730	550	840	550	960	550
Cromwell	330	350	370	350	410	350	460	350	530	350	610	350
Konawa	1,670	1,750	1,790	1,700	1,820	1,550	1,920	1,450	1,980	1,300	2,020	1,150
Lima	240	250	320	300	350	300	330	250	380	250	440	250
Maud (part)	380	400	420	400	410	350	460	350	460	300	440	250
Sasakwa	330	350	370	350	410	350	460	350	530	350	610	350
Seminole	8,770	9,200	9,910	9,400	11,010	9,400	12,150	9,200	13,720	9,000	15,420	8,800
Wewoka	5,530	5,800	6,120	5,800	6,680	5,700	7,270	5,500	8,230	5,400	9,290	5,300
City Subtotal	17,770	18,650	19,880	18,850	21,730	18,550	23,780	18,000	26,670	17,500	29,790	17,000
Balance of County	9,030	9,450	9,020	8,550	9,070	7,750	8,720	6,600	7,330	4,800	5,610	3,200
County Total	26,800	28,100	28,900	27,400	30,800	26,300	32,500	24,600	34,000	22,300	35,400	20,200

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ SEDIP = Successful Economic Development Initiative Plans.
3/ OESC = Oklahoma Employment Security Commission.

However, human resource problems and needs must be listed and recognized for two reasons. First, it is impossible to develop alternative plans for long-range water resource development without recognizing and taking these problems and needs into account; because they function as constraints on the future as long as they are unmet. Second, meeting these problems and needs will put demands on the public sector human and financial resources just like every other component in any long-range, overall economic development plan. Meeting these human resource problems and needs will require tradeoff or allocation of resources decisions during the entire course of establishing and achieving a long-range economic development plan. Human resource problems and needs briefly touched upon in this chapter are summarized as follows:

1. Per capita income in the study area is significantly below State and national levels.

2. Private sector economic activity is limited in much of the study area, resulting in public sector payrolls (local, State, and Federal government) providing more earnings (in six out of nine counties) than any private sector component such as trade, manufacturing, mining (including extraction of oil and gas), and services.

3. Much of the study area has unemployment rates significantly higher than the State or Nation.

4. Lack of economic opportunity has resulted in long-term outmigration in much of the study area which has resulted in more than a 50-percent population loss in some cases.

5. The better educated young people with current high-technology job skills training needed for economic development initiatives are the very people leaving the study area.

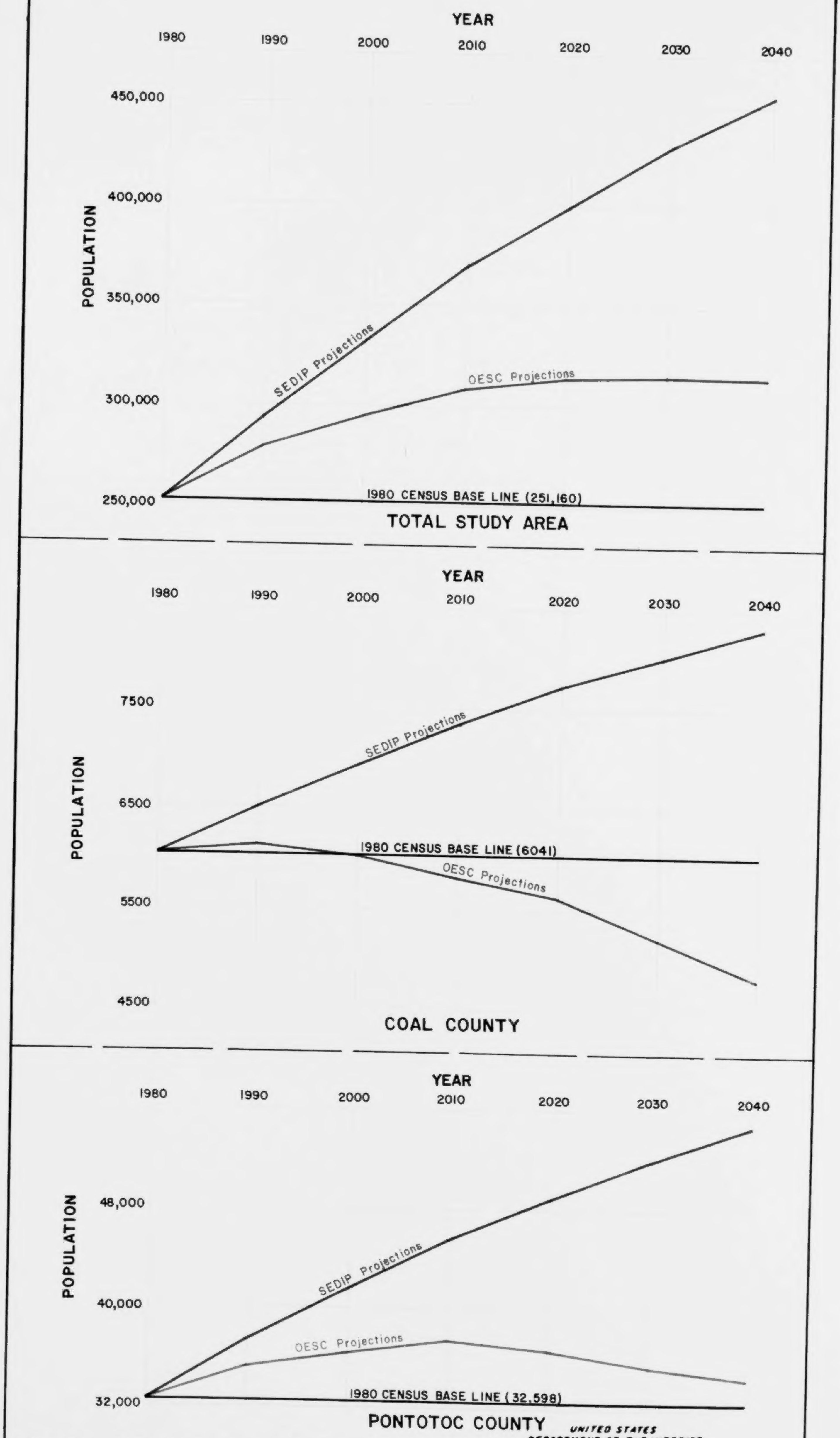
6. The remaining local labor force appears to be somewhat older with less formal education than State and national norms.

7. Some counties in the study area appear to be very limited in additional labor force potential that might be needed for economic development initiatives.

8. There appears to be a very limited tax base to finance all components of a comprehensive long-range development plan.

9. Population projections show that continuation of historic and present trends (OESC projections) will result in the continued decline of some of the study area counties and stagnation or eventual decline for many communities during the next 50 years.

10. The SEDIP population projections show that a sustained, 50-year coordinated economic development effort by study area communities, interest groups, counties, economic development planning districts, and RedArk could result in healthy growth of the region, alleviating many of the problems and providing the study area with an opportunity to participate equally with the rest of the State in future prosperity.



TOTAL STUDY AREA

COAL COUNTY

PONTOTOC COUNTY

SEDIP = Successful Economic Development Initiative Plans
OESC = Oklahoma Employment Security Commission

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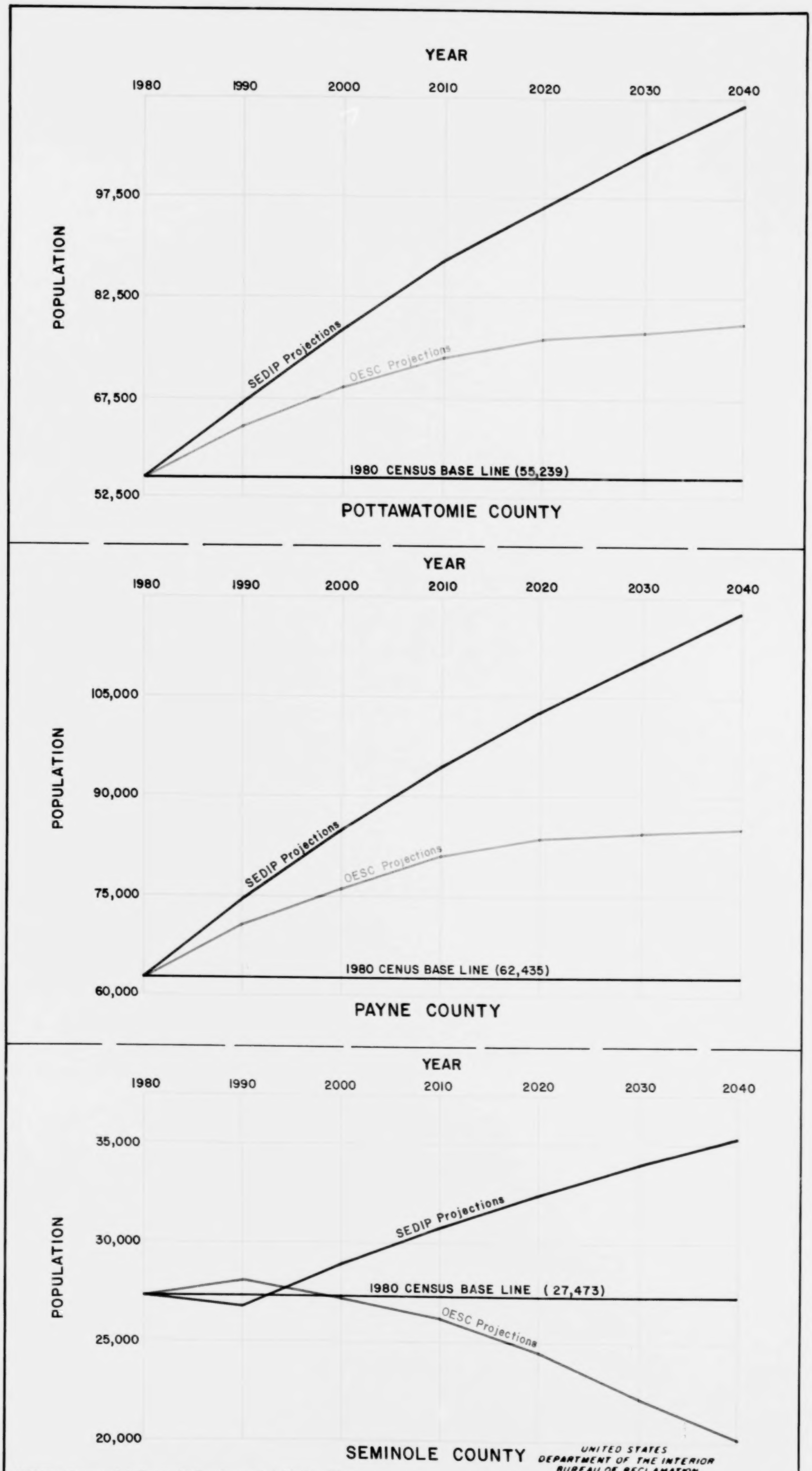
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

GRAPHIC COMPARISONS OF POPULATION
PROJECTIONS SHOWING: TOTAL STUDY AREA,
COAL and PONTOTOC COUNTIES

Amarillo, Texas *January, 1985*
Drawing No. 1484-500-30



SEDIP = Successful Economic Development Initiative Plans
OESC = Oklahoma Employment Security Commission

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BUREAU OF RECLAMATION
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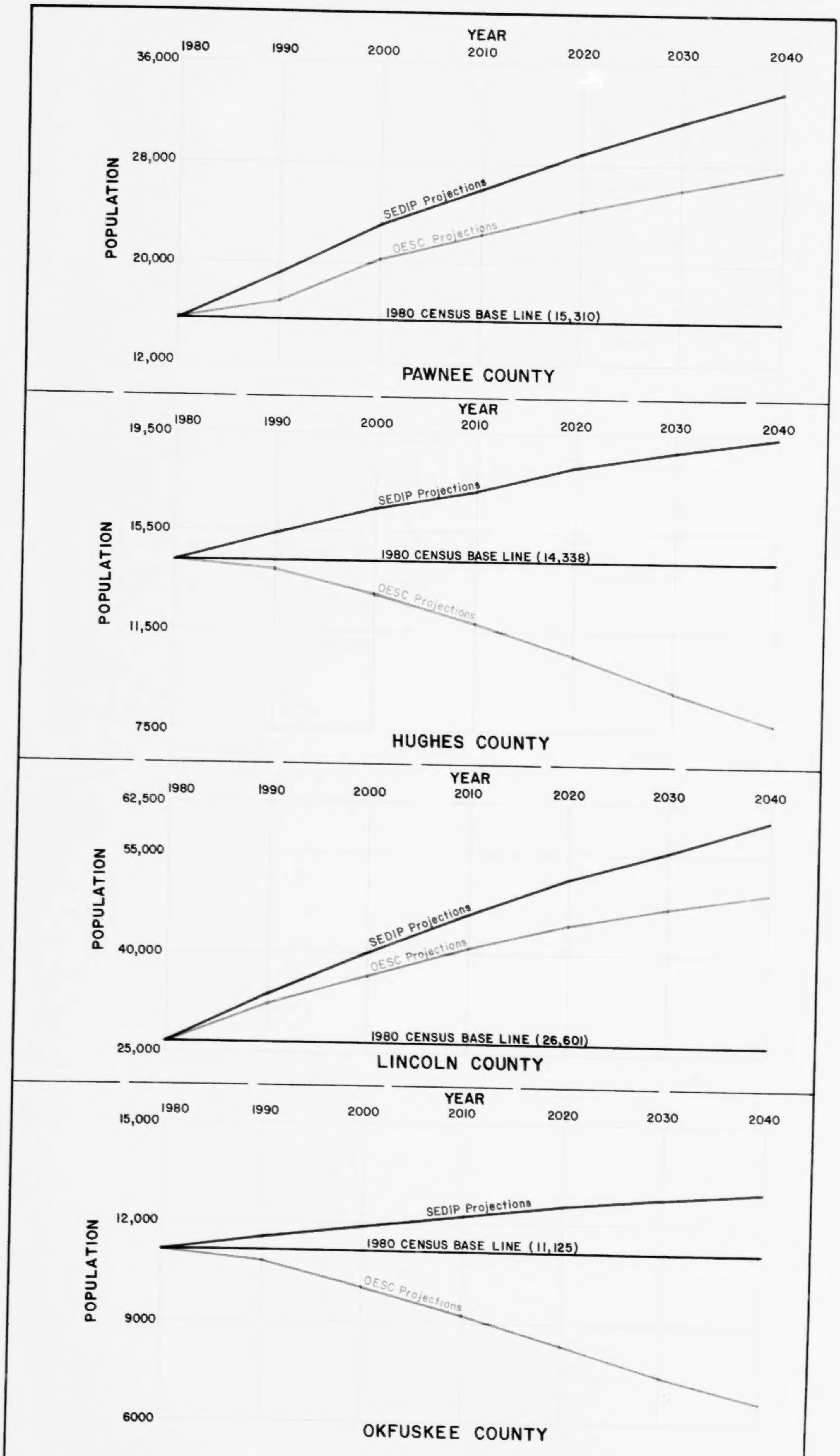
WATER SUPPLY STUDY

GRAPHIC COMPARISONS OF POPULATION PROJECTIONS SHOWING: POTTAWATOMIE, PAYNE and SEMINOLE COUNTIES

Amarillo, Texas January, 1985

Drawing No. 1484-500-31



SEDIP = Successful Economic Development Initiative Plans
OESC = Oklahoma Employment Security Commission

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY
GRAPHIC COMPARISONS OF POPULATION
PROJECTIONS SHOWING: PAWNEE, HUGHES,
LINCOLN and OKFUSKEE COUNTIES
Amarillo, Texas January, 1985
Drawing No. 1484-500-32

CHAPTER III - CULTURAL RESOURCES 1/

A. Introduction and Background

The purpose of the brief overview which follows is to identify the types of resources known/reported and those which are likely in the study area. As the study progresses, additional effort will supplement this information.

The varying levels of cultural resources (CR) investigations completed in and published information readily available for the area allow only a general picture to be drawn of the quantity and importance of the CR near specific potential damsites. Even so, the variety, complexity, and yet similarity of CR within the nine-county study area is apparent.

The overview is organized by county or watershed within the county. Much of the information is taken from the results of surveys conducted for SCS projects (see map No. 1484-500-19). The Oklahoma Conservation Commission's indexes of these investigations and copies of pertinent reports were very useful. 2/ Other sources checked include Oklahoma Archeology: A 1981 Perspective; Prehistory of Oklahoma; Historical Atlas of Oklahoma; Ghost Towns of Oklahoma; The Twenty-ninth Annual Report of the Board of Indian Commissioners, 1897; The National Register of Historic Places, and various reports on surveys of related/pertinent areas.

The National Register of Historic Places - 1972 includes only one entry for the nine counties of the east-central Oklahoma study area. This single entry does not reflect the importance or quality of the resources but rather the fact that little historical and archeological research has been done in the area and that little emphasis has been placed on recognizing those resources identified. Table III-1 lists sites within the study area which were on or nominated to the National Register of Historic Places (NRHP) as of November 9, 1984. Many of these are within the boundaries of towns; those which are outside settlements are plotted on map No. 1484-500-9. Some of these sites are located in the general vicinity of proposed damsites. None of the currently known NHRP sites should be affected by the development of a particular damsite. Nuyaka Mission, which falls in Okmulgee County, is included because of its proximity to the Nuyaka and Morse damsite locations.

With rare exception, the NHRP properties represent Oklahoma's recent history--the period beginning during the 1890's--and its Anglo culture. Several are missions which served as bases for missionary efforts as well as for education of the various Indian tribes. A few, such as the Moses Keokuk home and the Jim Thorpe House, recognize the accomplishments of Indians within the Anglo culture. Only the Roulston-Rogers Site represents the prehistoric period.

The missions listed are some of those established to educate and minister to the Indians who were relocated to the Oklahoma Territory from their homes in other parts of the United States. The order and point in time at which the groups settled within the Indian Territory and the study area reflect the order and timing of Anglo-American expansion through the country. The Louisiana Purchase of 1803 included the study area; at that time the Osage and to a lesser extent the Wichita, Caddo, and Quapaw occupied the area. In 1825 the United States obtained land between the Red River and the Kansas River from the Osage. Within a year the relocation of the Southeastern tribes began. The Creek were removed from Alabama and Georgia into the area which includes today's Lincoln, Creek, Okfuskee, Okmulgee, Pottawatomie, and Hughes Counties. In 1833 portions of the Seminole of Florida joined the Creek (by invitation); some resisted removal until the early 1840's.

Today's Pontotoc and Coal Counties were included in lands "given" to the Choctaw in exchange for their land in Mississippi and Alabama; removal was largely completed by the mid-1830's. In January of 1837, Chickasaw and Choctaw commissioners agreed on relocation of the Chickasaw from Mississippi to the western section of Choctaw lands (see map No. 1484-500-20). After 1855 the Chickasaw assumed complete control of this area, and their right to separately govern themselves was acknowledged (see map No. 1484-500-21).

The Creek and Seminole Tribes' sympathies lay with the Confederacy during the Civil War. After the Confederacy was defeated, the U.S. Government negotiated unilateral changes in the treaties which had established the tribes' land rights. The western half of Creek lands was taken from them, and the Seminole were assigned an area with roughly the same boundaries as present Seminole County. The remaining lands were distributed among the Sac and Fox, Pottawatomie, Shawnee, Iowa, and Kickapoo Tribes, groups from the Northern Plains and lower Great Lakes (see map No. 1484-500-22).

The Cherokee had been allotted land along the northern edge of the East-Central Oklahoma Study area which could be sold by them or for their benefit to friendly Indian tribes. By 1889 the Pawnee were present in that area on lands now incorporated in Pawnee County. Lands of today's Payne County were part of those designated "unassigned" which were opened for non-Indian settlement.

The Indian Appropriations Bill of 1889 provided for allotment of communally held lands to individual tribal members and allowed the sale of all but a small portion by the individual. These "excess" lands were opened for settlement by land runs as early as 1891 (see map No. 1484-500-22).

1/ For references, see section at end of report.

2/ All of the several reports were reviewed. The gist of their data is incorporated into the general statements below, although not all are referenced. The generous assistance of Charles Wallis, Jr. and Christopher Lintz is appreciated.

Table III-1
National Register of Historic Places
(Properties Within Towns in the
East-Central Oklahoma Study Area)

County	Town/City	Property Name
Pawnee	Pawnee	* Arkansas Valley National Bank
		* Pawnee Indian Agency
		* Corliss Steam Engine
		+ Pawnee County Courthouse
	Cleveland	+ Mullendore Mansion
Payne	Stillwater	* Old Central, Oklahoma State University
		* Berry, James E., House
		* Citizens Bank Building
		* Hoke Building
		* Seph Building
		* Walker Building
		+ Payne County Courthouse
	Yale	* Thorpe, Jim, House
Lincoln	Stroud	* Graham Hotel
		* Stroud Trading Company Building
		* Stroud, James W., House
	Prague	* Z.C.B.J. Lodge No. 46
	Chandler	+ Boston Store
		+ Building at 1014 Manvel Ave.
		+ Building at 720 Manvel Ave.
		+ Building at 812 Manvel Ave.
		+ Building at 814 Manvel Ave.
		+ Chandler Bookstore
		+ Clapp-Cuningham Building
		+ Feuquay Building
		+ Milly Building
		+ Murphy Building
		+ Oleson-Crane Building
		+ St. Cloud Hotel
		+ Wolcott Building
Okfuskee	Boley	* Boley Historic District
	Okemah	* Guthrie, Woody, House
		+ Okfuskee County Courthouse
Pottawatomie	Shawnee	* Santa Fe Depot
		* St. Gregory's Abbey and College
		* Beard Cabin
		* Governor's Mansion
		* Kerfoot House
		* Nuckolls House
		* Walker House
		+ Pottawatomie County Courthouse
Seminole	Seminole	* Grisso, W. E., Mansion
		+ Seminole County Courthouse
	Sasakwa	* Brown, Alice, House
	Wewoka	* Seminole Whipping Tree
		* Brown, Jackson, House
Hughes	Holdenville	* Holdenville City Hall
		* Turner, John E., House
	Stuart	* Stuart Hotel
Pontotoc	Ada	+ Pontotoc County Courthouse
Coal	(none within town limits)	

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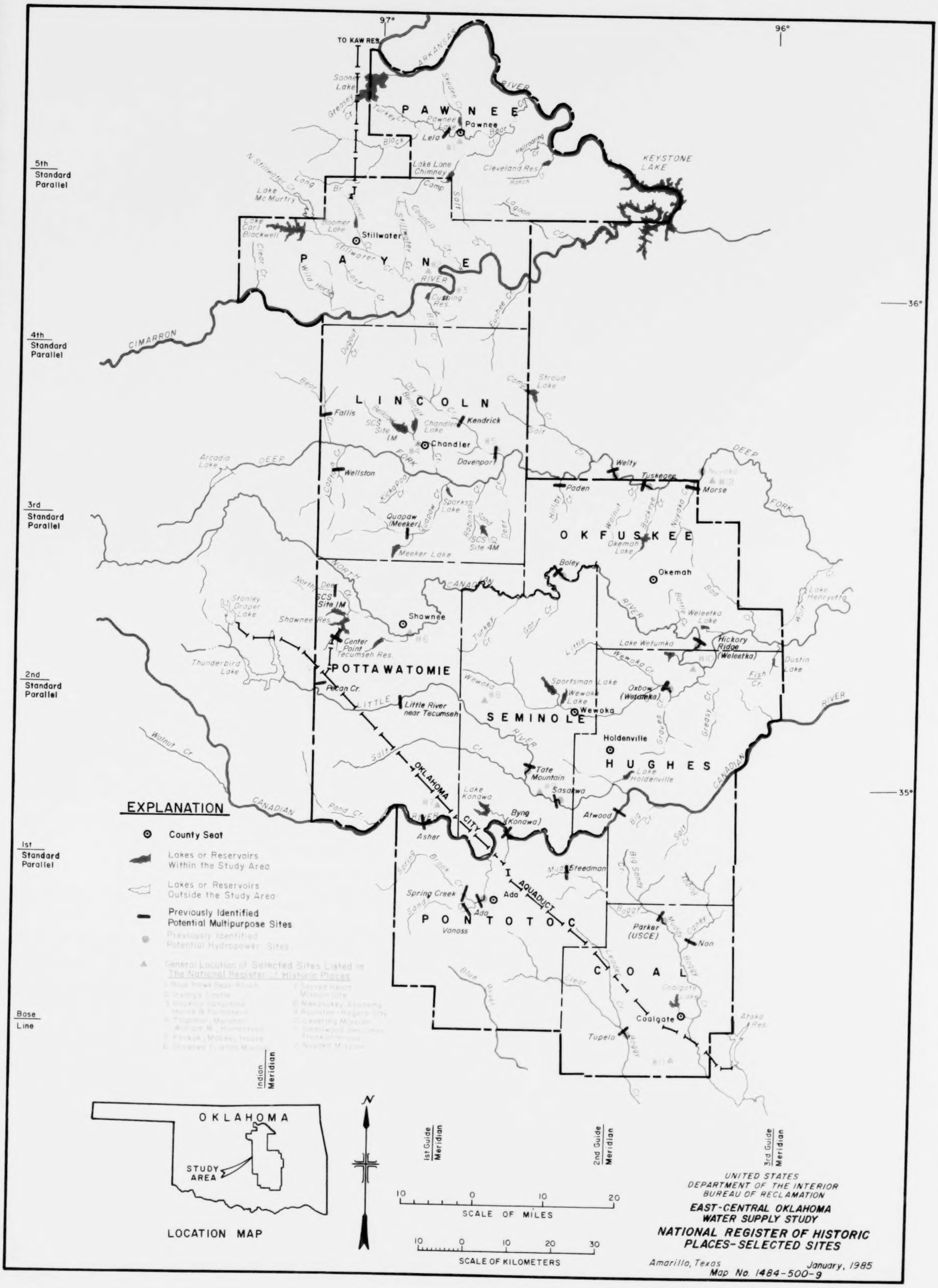
* Listed on the Register.
+ Nominated to the Register.

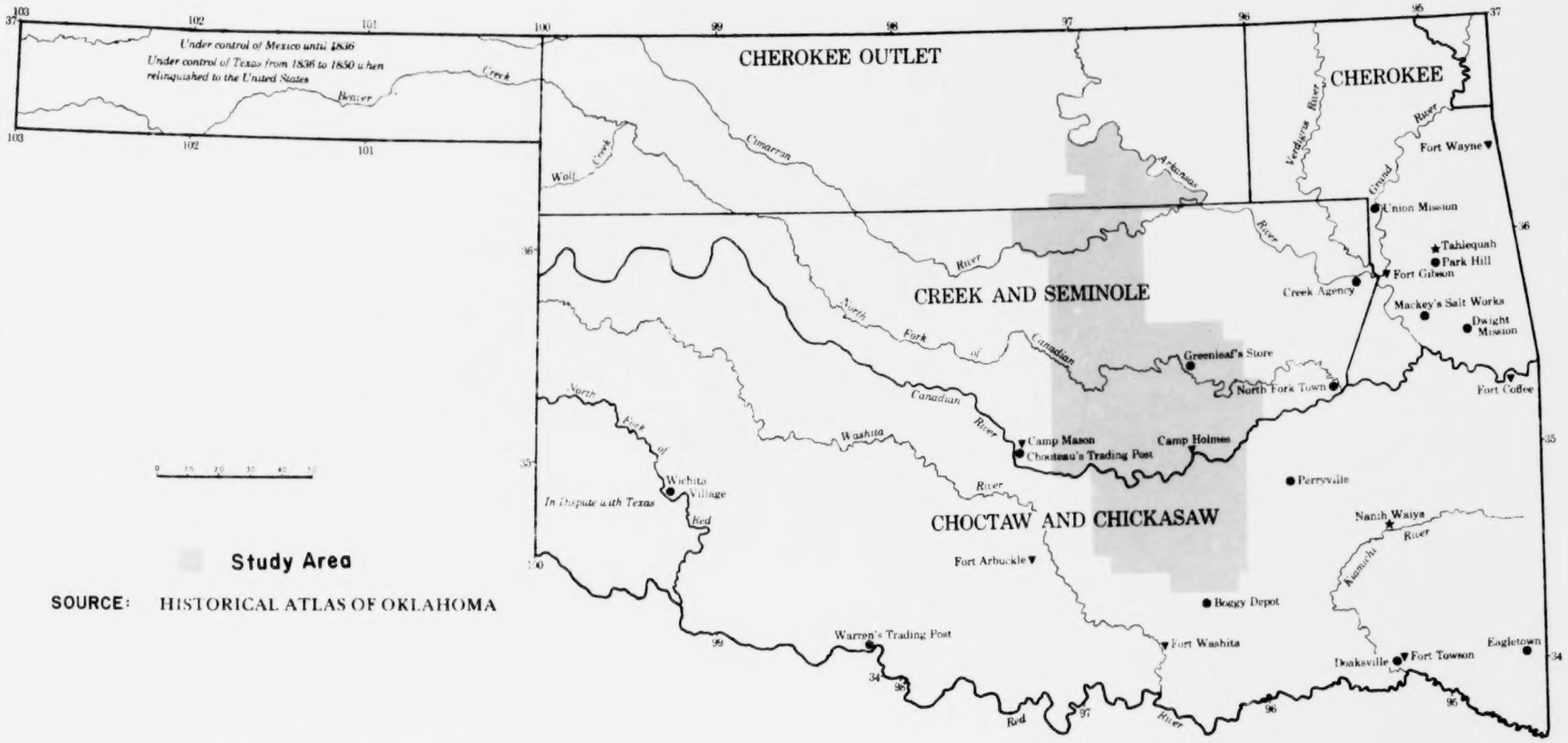

97°
96°
36°
35°
TO KAW RES.
5th Standard Parallel
4th Standard Parallel
3rd Standard Parallel
2nd Standard Parallel
1st Standard Parallel
Base Line
Indian Meridian
1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
PAWNEE
PAYNE
LINCOLN
OKFUSKEE
POTTAWATOMIE
SEMINOLE
HUGHES
PONTOTOC
COAL
ARKANSAS RIVER
CIMARRON
RIVER
DEEP FORK
NORTH CANADIAN
LITTLE RIVER
CANADIAN
KEYSTONE LAKE
Sooner Lake
Pawnee Lake
Pawnee
Lela
Lake Lone Chimney
Cleveland Res.
Lake McMurtry
Lake Carl Blackwell
Boomer Lake
Stillwater
Cushing Res.
Stroud Lake
Fallis
Kendrick
SCS Site IM
Chandler Lake
Chandler
Davenport
Arcadia Lake
Wellston
Sparks Lake
Quapaw (Meeker)
SCS Site 4M
Meeker Lake
Welty
Tuskegee
Paden
Nuyaka
Morse
Okemah Lake
Okemah
Boley
Lake Henryetta
Weleetka Lake
Lake Wetumka
Hickory Ridge (Weleetka)
Dustin Lake
Stanley Draper Lake
Shawnee Res.
SCS Site IM
Shawnee
Center Point
Tecumseh Res.
Thunderbird Lake
Pecan Cr.
Little River near Tecumseh
Sportsman Lake
Wewoka Lake
Wewoka
Oxbow (Wetumka)
Holdenville
Lake Holdenville
Tate Mountain
Sasakwa
Lake Konawa
Byng (Konawa)
Atwood
Asher
Steedman
Spring Creek
Ada
Vanoss
Parker (USCE)
Non
Coalgate Lake
Coalgate
Tupelo
Atoka Res.
OKLAHOMA CITY AQUADUCT
EXPLANATION
County Seat
Lakes or Reservoirs Within the Study Area
Lakes or Reservoirs Outside the Study Area
Previously Identified Potential Multipurpose Sites
Previously Identified Potential Hydropower Sites
General Location of Selected Sites Listed in The National Register of Historic Places
1 Blue Hawk Peak Ranch
2 Irving's Castle
3 Hopkins Sandstone House & Farmstead
4 Tilghman, Marshal William M., Homestead
5 Keokuk, Moses, House
6 Shawnee Friends Mission
7 Sacred Heart Mission Site
8 Mekasukey Academy
9 Roulston-Rogers Site
10 Levering Mission
11 Smallwood, Sen. Benjamin Franklin, House
12 Nuyaka Mission
OKLAHOMA
STUDY AREA
LOCATION MAP
N
10 0 10 20
SCALE OF MILES
10 0 10 20 30
SCALE OF KILOMETERS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

NATIONAL REGISTER OF HISTORIC PLACES-SELECTED SITES

Amarillo, Texas January, 1985
Map No. 1484-500-9

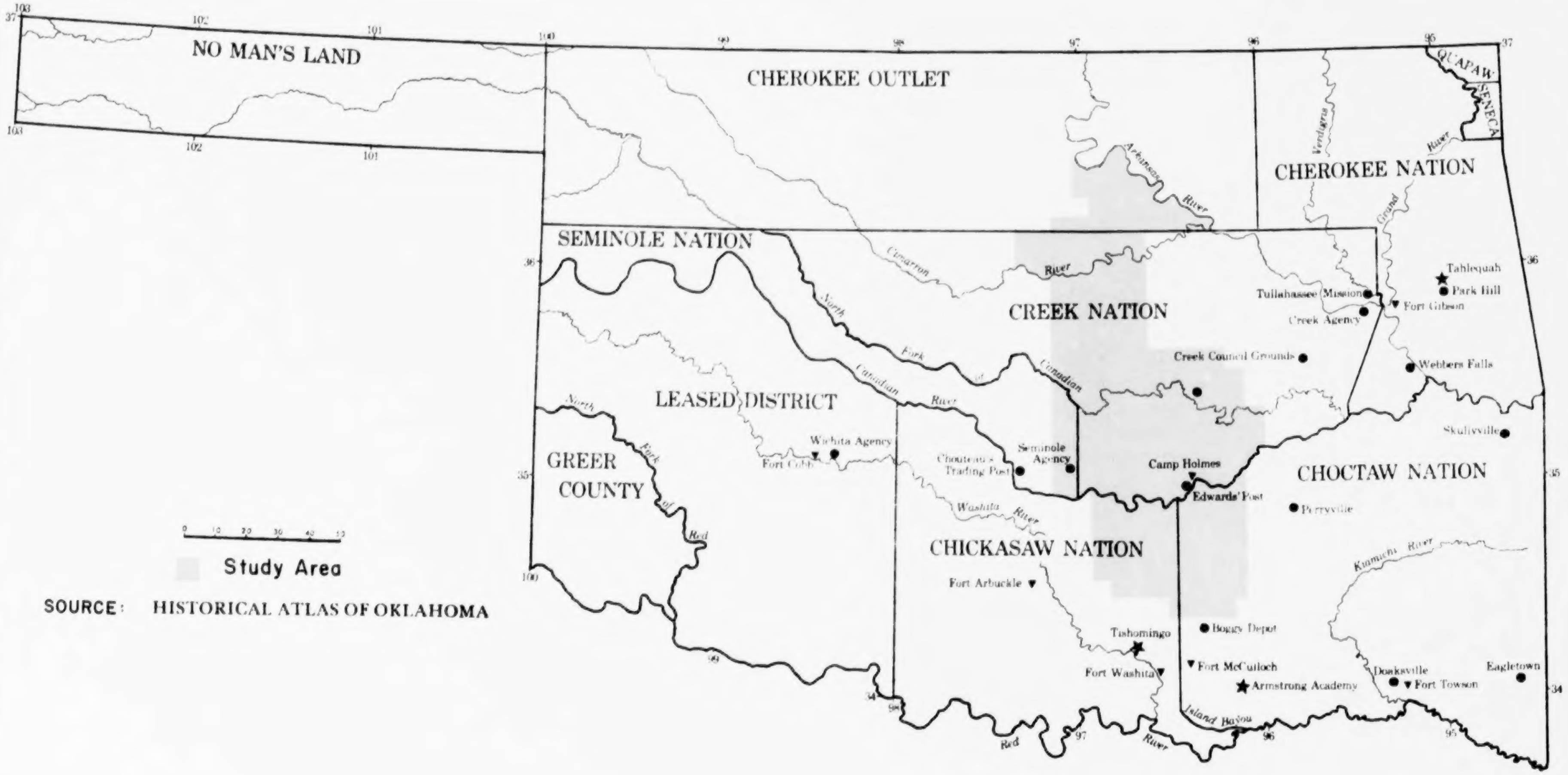

CHEROKEE OUTLET
CHEROKEE
CREEK AND SEMINOLE
CHOCTAW AND CHICKASAW
Under control of Mexico until 1836
Under control of Texas from 1836 to 1850 when relinquished to the United States
In Dispute with Texas
Beaver Creek
Wolf Creek
Cimarron River
Arkansas River
Verdigris River
Grand River
North Fork of Canadian
Canadian River
Washita River
North Fork of Red
Red River
Kiamichi River
Fort Wayne
Union Mission
Tahlequah
Park Hill
Fort Gibson
Creek Agency
Mackey's Salt Works
Dwight Mission
Fort Coffee
Greenleaf's Store
North Fork Town
Camp Mason
Chouteau's Trading Post
Camp Holmes
Perryville
Nanih Waiya
Fort Arbuckle
Boggy Depot
Fort Washita
Warren's Trading Post
Doaksville
Fort Towson
Eagletown
Wichita Village
Study Area
0 10 20 30 40

SOURCE: HISTORICAL ATLAS OF OKLAHOMA

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

INDIAN TERRITORY 1830-55

Amarillo, Texas January, 1985
Map No. 1484-500-20

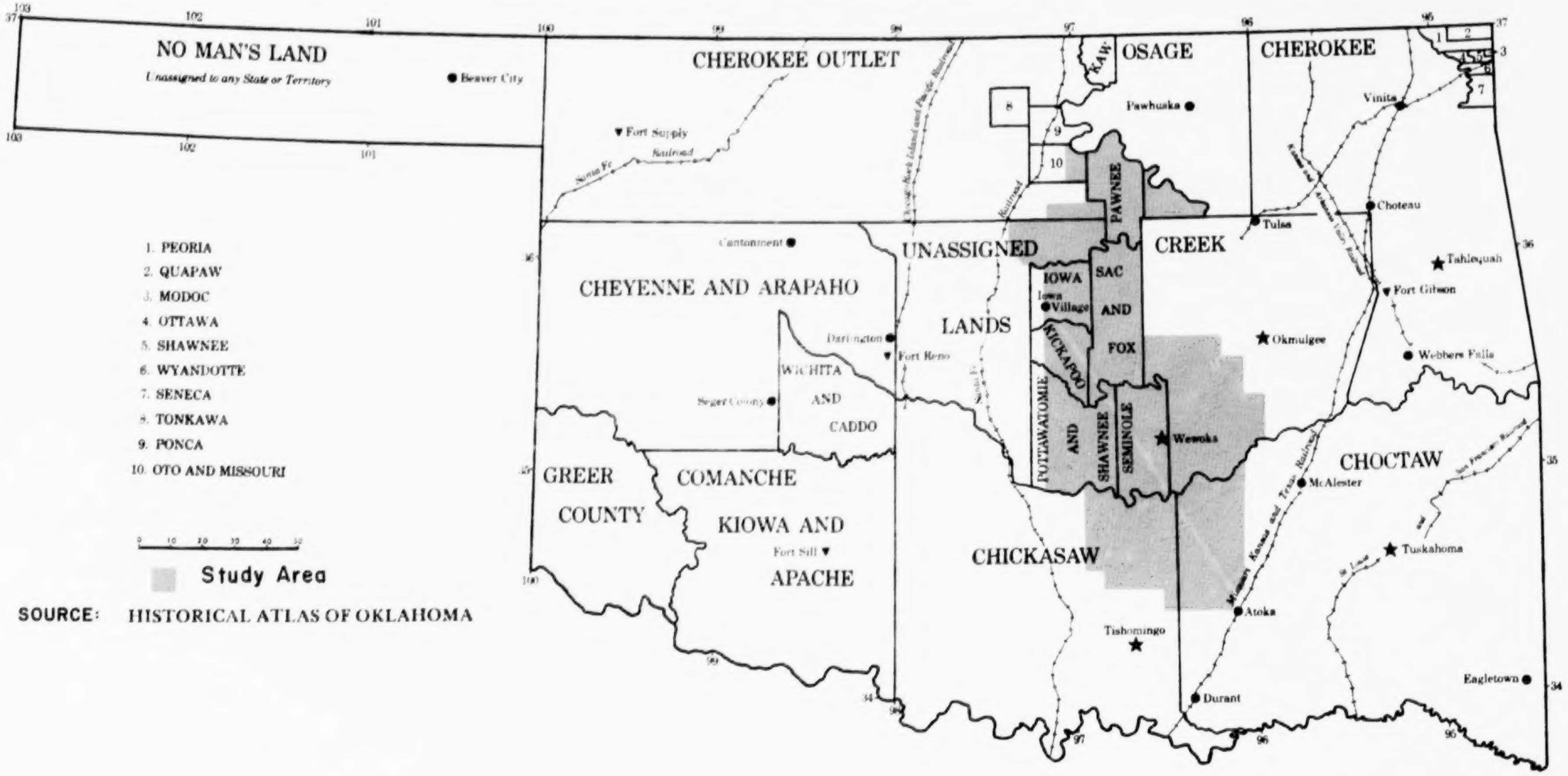

NO MAN'S LAND
CHEROKEE OUTLET
CHEROKEE NATION
QUAPAW
SENECA
SEMINOLE NATION
CREEK NATION
LEASED DISTRICT
GREER COUNTY
CHICKASAW NATION
CHOCTAW NATION
Verdigris
Grand
River
Arkansas River
Cimarron River
North Fork of Canadian
Canadian River
Washita River
North Fork of Red
Kiamichi River
Island Bayou
Red River
Tahlequah
Park Hill
Fort Gibson
Tullahassee Mission
Creek Agency
Creek Council Grounds
Webbers Falls
Skullyville
Seminole Agency
Chouteau's Trading Post
Camp Holmes
Edwards' Post
Perryville
Wichita Agency
Fort Cobb
Fort Arbuckle
Tishomingo
Fort Washita
Boggy Depot
Fort McCulloch
Armstrong Academy
Doaksville
Fort Towson
Eagletown
103
102
101
100
99
98
97
96
95
94
37
36
35
34
0 10 20 30 40 50
Study Area

SOURCE: HISTORICAL ATLAS OF OKLAHOMA

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

INDIAN TERRITORY 1855-66

Amarillo, Texas January, 1985
Map No. 1484-500-21


NO MAN'S LAND
Unassigned to any State or Territory
Beaver City
CHEROKEE OUTLET
Fort Supply
Santa Fe Railroad
KAW
OSAGE
Pawhuska
CHEROKEE
Vinita
Choteau
Tulsa
Tahlequah
Fort Gibson
Webbers Falls
PAWNEE
CREEK
Okmulgee
UNASSIGNED LANDS
IOWA
Iowa Village
SAC AND FOX
KICKAPOO
POTTAWATOMIE AND SHAWNEE
SEMINOLE
Wewoka
Darlington
Fort Reno
Cantonment
CHEYENNE AND ARAPAHO
WICHITA AND CADDO
Seger Colony
GREER COUNTY
COMANCHE
KIOWA AND APACHE
Fort Sill
CHICKASAW
Tishomingo
CHOCTAW
McAlester
Tuskahoma
Atoka
Durant
Eagletown
Missouri, Kansas and Texas Railroad
St. Louis and San Francisco Railroad
Chicago, Rock Island and Pacific Railroad
1. PEORIA
2. QUAPAW
3. MODOC
4. OTTAWA
5. SHAWNEE
6. WYANDOTTE
7. SENECA
8. TONKAWA
9. PONCA
10. OTO AND MISSOURI
0 10 20 30 40 50
Study Area

SOURCE: HISTORICAL ATLAS OF OKLAHOMA

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

INDIAN TERRITORY 1866-89

Amarillo, Texas January, 1985
Map No. 1484-500-22

The Indians who were relocated to the Oklahoma Territory, including the study area, followed much the same lifestyle as they had in their homelands. Those who had already accepted the Anglo way-of-life were successful in establishing trading and population centers, primarily along major streams. Others settled in rural areas and lived simple lives. The archeological sites created by these different settlement types are distinctive. In the rural areas where proposed damsites are placed, the simple lifestyle leaves little physical evidence; and it is often difficult to distinguish between historic Indian and historic Anglo sites. Barr (1963:36) notes that in Lincoln and Creek Counties near the Sac and Fox Agency, "... numerous structures of these people dot the countryside in various stages of decomposition," but that much of the material associated is identical to that of Anglo homesteads.

Given the rapid and unusually structured settlement of the study area, the potential for both historic Indian and historic Anglo archeological sites throughout the study area is good. The specifics may vary depending on which group settled the particular area and the nature of the remains, but all are important. Many of the sites may be "unimpressive," small scatters of debris. Thoughtfully oriented studies of these could, however, yield important insights into the processes at work in the early settlement period.

The prehistory of the study area is known from survey, a limited amount of testing, and the results of a small number of widely scattered excavations. With the exception of the PaleoIndian period, all of man's time of residence in the New World is represented, including the gatherer-hunter stage of the Archaic, the transitory Woodland horticulturists, the horticultural-agricultural Caddoan and Plains Villagers, and the Late Prehistoric hunters. The PaleoIndian/Early Archaic material has largely been limited to surface finds. That these early people lived in or used the resources of the area is virtually sure; the residue of that use is illusive. Sites of this period are often deeply buried and are without structural remains. Many small lithic scatters without diagnostics, which are noted in the specific county site data below, attest to use of the area. Individually these provide little information; plotted over a broad area and sampled using a thoughtfully developed and rigorously defined program of research, their potential is considerable. Just as the historic resources of the area have the potential to provide a picture of recent past processes, the virtually unstudied prehistoric resources may reveal the lifestyles of more distant people.

B. Review of Specific Site Data for Study Area

The bulk of data on specific resources within the study area has been accumulated since 1970 in conjunction with highway and water resource development; very little testing/excavation has been completed. Table III-2 shows the number of prehistoric and historic sites shown in Oklahoma Archeology: A 1981 Perspective for each of the nine counties. The brief statement of kinds of resources located in the counties/watersheds which follows incorporates some data which postdates that included in The Perspective but should not contradict it.

Table III-2
Total Cultural Resource Sites
(Recorded by County for the East-Central Study Area)

County	Number of sites
Pawnee	175
Payne	52
Lincoln	66
Okfuskee	40
Pottawatomie	66
Seminole	76
Hughes	56
Pontotoc	157
Coal	63

1. Pawnee County. Sites recorded during surveys in Upper and Lower Black Bear Creek Watersheds for specific impoundment projects included small prehistoric lithic workshops without diagnostic materials, but which probably include Archaic or Plains Woodland materials, a possible Plains Villager site, and historic sites. In the general area of the Lela damsite the remains of a 1943 copper mine, a pre-1930's homestead, a copper prospecting area, and a lithic scatter were found. In 1952, the University of Oklahoma investigated the Terlton burial which was located at a depth of 11.6 feet.

A 1952 survey of Keystone Reservoir area identified 84 sites and 24 possible sites, while a shoreline survey in 1980 defined 83 historic sites and 198 prehistoric ones.

2. Payne County. Surveys, largely in Stillwater Creek Watershed, have recorded materials identified as Early Archaic through Late Historic. Many sites consist of scattered lithic debris without diagnostics. Historic 1900's farmsteads are among the more common resources.

3. Lincoln County. Surveys of impoundments in the Kickapoo Nations, Robinson Creek, and Quapaw Creek Watersheds and testing of some located sites have identified materials ranging from the Early to Late Archaic to Woodland and Plains Villager and Late Historic. A number of small prehistoric lithic scatters have contained no diagnostic materials. At Site 1M on Bellcow Creek in the Kickapoo Nations Watershed, testing revealed a prehistoric camp with materials from the Late Archaic through the Late Plains Villager Period, as well as two historic farmsteads.

Approximately 10 miles to the east of the Davenport damsite and just north of the Paden damsite (in Creek County), a historic Indian cemetery with suprastructures was identified. The Iowa Mission, listed on the Oklahoma Landmarks Inventory, is near the Wellston damsite.

An 1892 map (Wallis 1981) which includes much of Lincoln County shows towns whose names are those of the proposed damsites of Fallis, Wellston, and Davenport. Wellston was established as a trading post by 1880. Many other small communities sprang up along the early railroads which served the county from 1892-1903 until 1924. Historic farmsteads, many of which were associated with these communities, were among the most common sites identified in all three Lincoln County watersheds.

In the general vicinity of the Quapaw damsite, Early and Middle Archaic and Late Historic materials were again second in frequency only to unidentified lithic scatters/workshops. A number of Plainview-like points were also recovered at a Kickapoo homestead site in the vicinity of the Quapaw damsite.

4. Okfuskee County. Survey within the Okfuskee County Tributaries Watershed has recorded sites in the general vicinity of the Paden, Morse, Tuskegee, and possibly the Welty damsites. In addition the historic data includes reference to the fact that the towns of Weleetka, Boley, and Paden were established along the route of the abandoned Fort Smith and Western Alabama Railroad (Wallis 1979). Known historic sites include Honey Springs, an 1880 homestead; Fort Holmes, established in 1834 and possibly in service until the Civil War; and Edwards Trading Post, which also served from the 1830's until the Civil War.

Included in the archeological sites are several prehistoric, limited occupation camps and lithic resource areas, Woodland Period burned rock mound sites, and a number of Late Historic homesteads. Two late 1800's-early 1900's Creek cemeteries are notable. One (OF-23) with sandstone vaulted graves, overlooks the Buckeye Creek flood plain in the general area of the Tuskegee damsite, approximately 4 miles from the Deep Fork. The other (OF-24) is a family cemetery found with a late 1800's Creek homestead.

5. Pottawatomie County. The results of survey in the Pott-Sem-Turkey Creek Watershed, which includes some of Seminole County, and in the Salt Creek Watershed follow the pattern of a few Late Archaic and Late Prehistoric materials along with many sites of unknown Prehistoric affiliation and Late Historic sites.

The Van Schuyver site in south Pottawatomie County is a Late Prehistoric campsite with a number of bison bone tools and clay figures and pipes dating to approximately A.D. 1100-1400.

East and north of the Asher damsite and north of the Byng damsite, there is an area of early 1900's oil development.

The location of the Jesse Chisholm Trading Post which was established in 1818 is reported to be approximately 2 miles east of Asher; and the Sacred Heart Mission site, shown on map No. 1484-500-9, lies approximately 10 miles from the Asher damsite.

6. Seminole County. The Roulston-Rogers Site, a burned rock mound dating to A.D. 640-680, which is listed (as noted above) on the NRHP and shown on map No. 1484-500-9, is located in southeast Seminole County on the Little River.

Approximately 5 miles north of the Byng damsite there is a historic Indian cemetery believed to be either Creek or Seminole which has graves with suprastructures similar to those noted above in Lincoln County.

Other sites in the county include Prehistoric lithic scatters and Late Historic homesteads.

7. Hughes County. In the survey of the Parker damsite (Hughes and Coal Counties) in 1972, 24 prehistoric sites were discovered representing the Late PaleoIndian/Early Archaic through Late Archaic periods, though most materials fell in the Middle to Late Archaic. Three historic cemeteries were located including 2 with 20+ and 40+ graves.

Another survey in the county has identified a number of sites of unknown Prehistoric age, several Late Historic sites, one Caddoan site, and materials identified as being from the "post-Archaic" period.

Materials of Creek derivation are likely, though not specifically noted.

8. Pontotoc County. Survey in the Upper Clear Boggy and Sandy Creek Watersheds has located a number of sites of unknown Prehistoric affiliation, a few of Late Archaic age, possible Woodland materials, at least one Caddoan and one Early Mississippian site, as well as Late Historic sites. (In 1979, there were 78 known sites in the Pontotoc County portion of Sandy Creek.) In the general area of the Vanoss and Spring Creek damsites (west of Ada, Oklahoma), the Pickett-Switch Site, which was excavated during the 1930's, produced apparent late Woodland/early Plains Villager materials, including houses and burials. The George Site to the southeast of Ada also had a house and a burial, plus pottery, cache pits, and arrowpoints of Plains Villager derivation.

Materials from the Choctaw and Chickasaw are probable; the towns of Center (near the Vanoss damsite) and Roff were established by the Chickasaw.

A number of historic roads and trails apparently crossed the county or followed the Canadian River on its north side, though at this time none are known to cross potential damsites.

In the Steedman damsite area, sites from the Late Archaic, Early Caddoan, and Late Historic have been located.

9. Coal County. The results of survey for Parker Reservoir in Hughes and Coal Counties are noted above. Survey in the Upper Muddy Boggy Creek area revealed relatively few sites in the area of Parker and Non damsites. A Late Archaic and Late Prehistoric site were noted in the general vicinity of the Non damsite, while those in the Parker damsite area include unknown Prehistoric, possibly Early Caddoan, and Late Historic materials.

C. Conclusion - Problems and Needs

As is so often the case, the known CR of the study area only hint at its use through time by various groups. Enough survey has been completed in the study area during the last 10 years to indicate the diversity of cultural material present, particularly in areas considered as potential water resource development sites. The need to locate/identify presently unknown sites and thoughtfully examine a cross section of these is great. Much has been lost to development, farming, and erosion caused by farming activities during the past 50 years. Future expansion will exacerbate the problem.

The opportunity to identify important sites and document their use within the context of the East-Central Oklahoma Study exists. Doing so preserves the past by making it available to today's residents and visitors to the area. A staged program of CR investigations to realize the opportunity to identify prehistoric and historic sites would accompany any future Reclamation study or construction in the study area.

CHAPTER IV - HUNTING, FISHING, RECREATION, AND TOURISM RESOURCES

A. Introduction

The 1982 State Comprehensive Outdoor Recreation Plan (SCORP) divides the State into numbered planning regions that are the same as the economic development planning districts. Thus, the study area includes all of SCORP Planning Region 5 (COEDD) and two counties (Coal and Pontotoc) of SCORP Planning Region 4 (SODA).

B. Inventory of Existing Recreation and Tourism Facilities

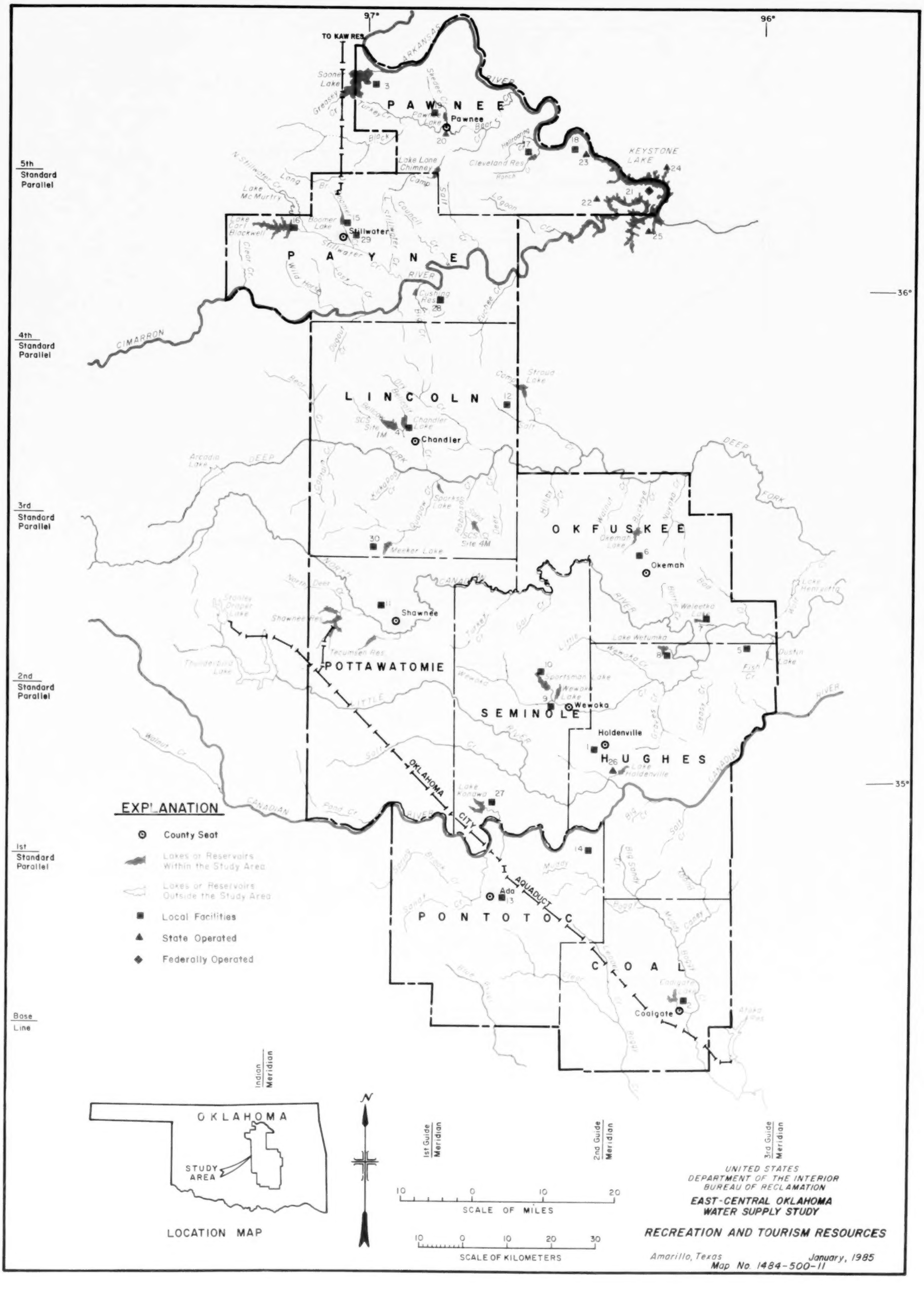
There are numerous locally operated or private recreational resources within the east-central Oklahoma region. These include small city lakes and local parks; museums; and facilities for camping, fishing, swimming, and other water-related activities. These facilities are widely dispersed within the study area and provide opportunities mainly to a local market area. Some of these attractions and their locations are found in table IV-1.

Table IV-1
Locally Owned and Operated Recreation and Tourism Facilities
(East-Central Oklahoma Water Supply Study, January 1985)

Name of Area	Locations (Community)	Numeric Locations (on map No. 1484-500-11)
Holdenville City Lake	Holdenville	1
Coalgate City Lake	Coalgate	2
Coalgate City Park	Coalgate	2
Coal County Historical and Mining Museum	Coalgate	2
Sooner Lake	Watchorn	3
Chandler City Lake	Chandler	4
Tilghman Park	Chandler	4
Lincoln County Historical Society Museum of Pioneer History	Chandler	4
Dustin City Lake	Dustin	5
Okemah Lake	Okemah	6
Territory Town USA	Okemah	6
Weleetka City Lake	Weleetka	7
Wetumka Lake	Wetumka	8
Lake Wewoka	Wewoka	9
Seminole Nation Museum	Wewoka	9
Sportsman Lake	Seminole	10
Twin Lakes	Shawnee	11
Museum of Special Interest Cars	Shawnee	11
Pottawatomie County Historical Society Museum	Shawnee	11
The Mabee-Gerrer Museum of St. Gregory's Abbey and College	Shawnee	11
Foster Park	Stroud	12
Stroud City Lake	Stroud	12
Stroud Municipal Lake	Stroud	12
U.S. Senator Robert S. Kerr's Log Cabin Birthplace	Ada	13
Kallihoma Recreation Area	Allen	14
Boomer Lake and Park	Stillwater	15
Carl Blackwell Lake	Stillwater	16
Cleveland City Lake	Cleveland	17
East Levi Park	Cleveland	18
Triangle Oil and Gas Historical Museum	Cleveland	18
Pawnee City Lake	Pawnee	19
Pawnee Bill Museum	Pawnee	20
Lake Konawa	Konawa	27
Cushing City Lake	Cushing	28
National Wrestling Hall of Fame	Stillwater	29
Meeker Lake	Meeker	30

- - - - - - - - - -

The only State or Federal recreation areas within the study area are those associated with Keystone Lake in Pawnee, Creek, and Tulsa Counties. These facilities are listed in table IV-2. There are three State-operated parks/recreation areas on Keystone Lake, only one of which is located in a study area county. The Keystone Public Hunting Area is operated by the Oklahoma Department of Wildlife Conservation (ODWC) under license from the Corps. The Corps operates several water-related recreation areas and allows public hunting on Keystone Lake. The ODWC also operates a fish hatchery near Holdenville in Hughes County.


97°
96°
TO KAW RES.
PAWNEE
PAYNE
LINCOLN
OKFUSKEE
POTTAWATOMIE
SEMINOLE
HUGHES
PONTOTOC
COAL
Pawnee
Stillwater
Chandler
Okemah
Shawnee
Wewoka
Holdenville
Ada
Coalgate
ARKANSAS RIVER
CIMARRON RIVER
DEEP FORK
NORTH CANADIAN RIVER
LITTLE RIVER
CANADIAN RIVER
KEYSTONE LAKE
Sooner Lake
Pawnee Lake
Lake Lone Chimney
Cleveland Res.
Lake McMurtry
Lake Carl Blackwell
Boomer Lake
Cushing Res.
Stroud Lake
Chandler Lake
SCS Site 1M
Sparks Lake
SCS Site 4M
Meeker Lake
Arcadia Lake
Okemah Lake
Weleetka Lake
Lake Henryetta
Lake Wetumka
Dustin Lake
Stanley Draper Lake
Shawnee Res.
Tecumseh Res.
Thunderbird Lake
Sportsman Lake
Wewoka Lake
Lake Holdenville
Lake Konawa
Coalgate Lake
Atoka Res.
OKLAHOMA CITY AQUADUCT
5th Standard Parallel
4th Standard Parallel
3rd Standard Parallel
2nd Standard Parallel
1st Standard Parallel
Base Line
36°
35°
Indian Meridian
1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
1
3
4
5
6
7
8
9
10
11
12
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14
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30
EXPLANATION
County Seat
Lakes or Reservoirs Within the Study Area
Lakes or Reservoirs Outside the Study Area
Local Facilities
State Operated
Federally Operated
OKLAHOMA
STUDY AREA
LOCATION MAP
N
10 0 10 20
SCALE OF MILES
10 0 10 20 30
SCALE OF KILOMETERS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

**EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY**

RECREATION AND TOURISM RESOURCES

Amarillo, Texas January, 1985
Map No. 1484-500-11

Table IV-2
State/Federal Recreation Areas and Facilities
(East-Central Oklahoma Water Supply Study, January 1985)

Name of Area	Location (community)	Numeric Location (on map No. 1484-500-11)
Keystone Lake (Corps' parks)	Cleveland	21
Appalachia Bay Park		
Cimarron Park		
Cowskin Bay Park North		
Cowskin Bay Park South		
Pawnee Cove Park North		
Pawnee Cove Park South		
Sandy Park		
Washington Irving Park North		
Washinton Irving Park South		
Keystone State Public Hunting Area	Cleveland	22
Feyodi Creek Recreation Area	Cleveland	23
Walnut Creek State Park 1/	Tulsa 1/	24
Keystone State Park 1/	Tulsa 1/	25
Holdenville State Fish Hatchery	Holdenville	26

1/ Outside nine-county study area.

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C. Fishing and Hunting Supply and Needs

The public use of fish and wildlife resources, either for consumptive use (hunting or fishing) or nonconsumptive use (nature study or photography) is essentially unaffected by drainage area boundaries or political subdivisions such as county lines. Supply, demand, and unmet needs are generally only valid on a more regional basis or as a statewide assessment. There are two basic sources of data which provide a means to identify fish and wildlife resource-use-related problems, needs, and opportunities within the study area. These are the SCORP and the National Survey of Hunting, Fishing and Wildlife Associated Recreation (1980) published by U.S. Fish and Wildlife Service (FWS) and the Bureau of the Census.

The study area involves an area bounded by county lines and includes Payne, Pawnee, Lincoln, Pottawatomie, Okfuskee, Hughes, Seminole, Pontotoc, and Coal Counties. This area falls mostly within SCORP Planning Region 5 and partially within SCORP Planning Region 4 (see map No. 1484-500-33).

The 1980 National Hunting and Fishing survey includes a statistical analysis of hunting and fishing use in various regions in the State. Counties within the study area fall within five of these Regions (1, 3, 4, 5, and 6). Since recreational use of the fish and wildlife resource is not county related, it is difficult to compile meaningful data directly applicable to the study area from this survey as well as demand/supply data from the SCORP. The relationship of the study area to these regions is displayed on map No. 1484-500-34.

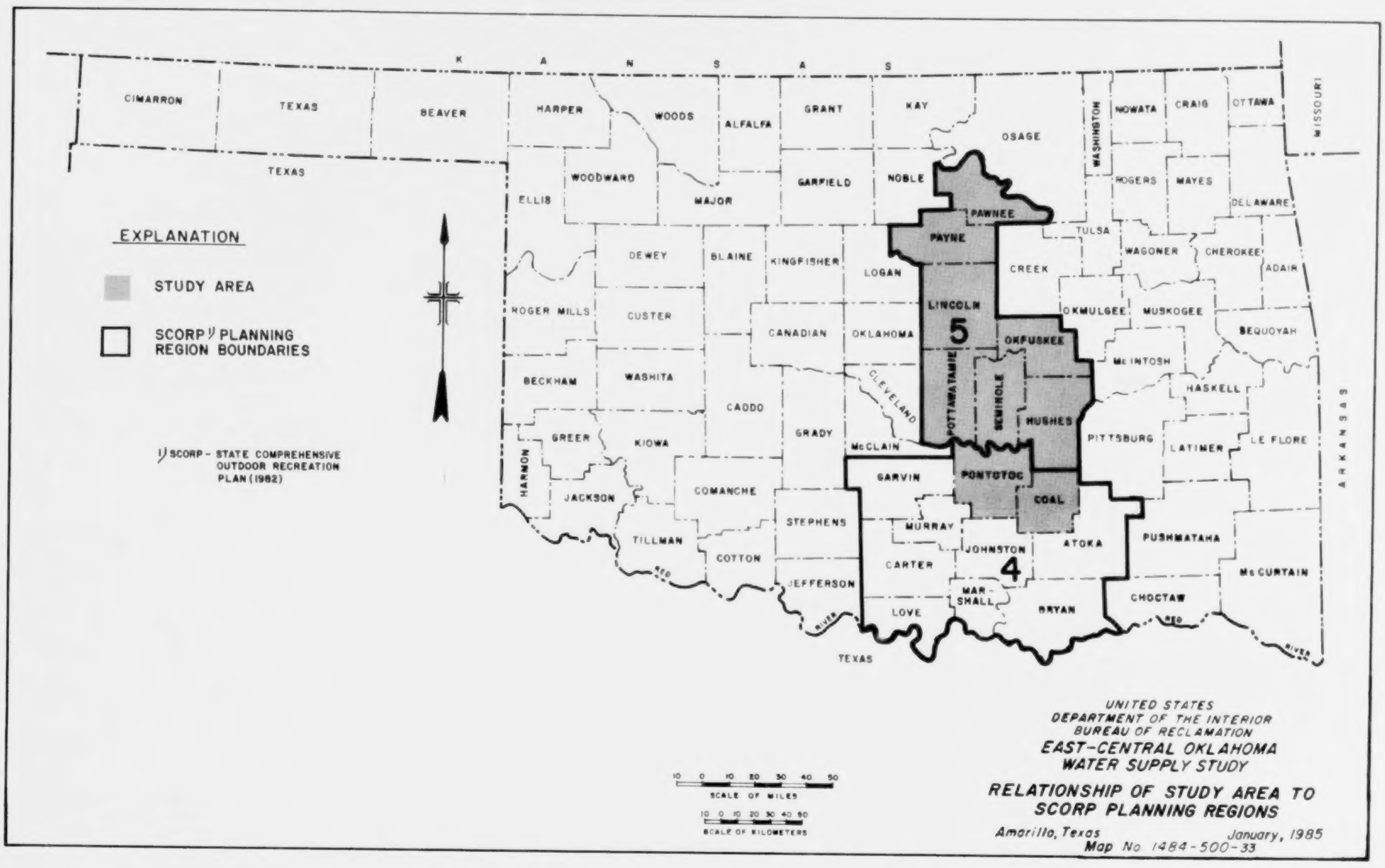
Table IV-3 presents data on hunting and fishing supply, demand, and needs extracted from the SCORP. Keystone Lake, partially within Pawnee County, provides the only State or Federal public use or hunting/fishing areas within SCORP Region 5. This region includes seven of the nine counties included in the study area. Region 4 has substantial State and Federal park and wildlife area acreage, but the majority is clustered in the vicinity of Lake Texoma and other Federal or State reservoirs to the south of the study area. The supply, demand, and needs data presented have a number of limitations. These include:

1. Only a relative assessment of scarcity or abundance of recreation resources on a regional level is possible. Local situations are not addressed.

2. Only public facility supply is included.

3. Fishing and hunting estimates are based on acreage requirements; stream fishing use is not addressed separately.

4. Participation and preferences were based on user surveys in 1981 which may have changed.


EXPLANATION
STUDY AREA
SCORP 1/ PLANNING REGION BOUNDARIES
K A N S A S
MISSOURI
ARKANSAS
TEXAS
RED RIVER
CIMARRON
TEXAS
BEAVER
HARPER
WOODS
ALFALFA
GRANT
KAY
OSAGE
WASHINGTON
NOWATA
CRAIG
OTTAWA
ELLIS
WOODWARD
MAJOR
GARFIELD
NOBLE
PAWNEE
ROGERS
MAYES
DELAWARE
PAYNE
TULSA
WAGONER
CHEROKEE
ADAIR
DEWEY
BLAINE
KINGFISHER
LOGAN
CREEK
ROGER MILLS
CUSTER
CANADIAN
OKLAHOMA
LINCOLN
OKMULGEE
MUSKOGEE
SEQUOYAH
5
OKFUSKEE
McINTOSH
BECKHAM
WASHITA
CADDO
CLEVELAND
POTTAWATOMIE
SEMINOLE
HUGHES
HASKELL
GREER
KIOWA
GRADY
PITTSBURG
LATIMER
LE FLORE
HARMON
JACKSON
McCLAIN
GARVIN
PONTOTOC
COAL
COMANCHE
STEPHENS
MURRAY
TILLMAN
COTTON
CARTER
JOHNSTON
ATOKA
PUSHMATAHA
McCURTAIN
4
JEFFERSON
MAR-SHALL
BRYAN
CHOCTAW
LOVE
SCALE OF MILES
10 0 10 20 30 40 50
SCALE OF KILOMETERS
10 0 10 20 30 40 50

1/ SCORP - STATE COMPREHENSIVE OUTDOOR RECREATION PLAN (1982)

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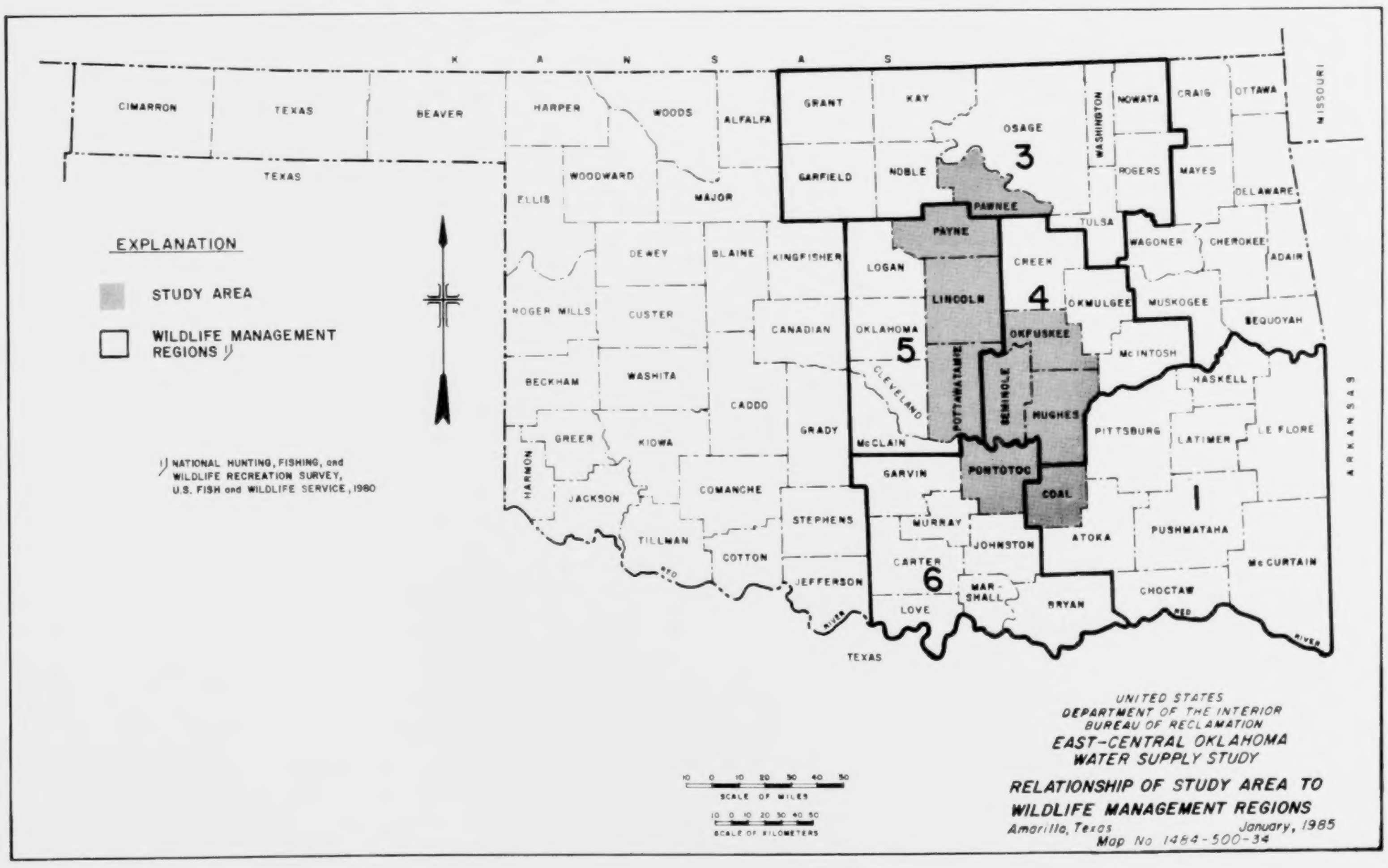
WATER SUPPLY STUDY

RELATIONSHIP OF STUDY AREA TO SCORP PLANNING REGIONS
Amarillo, Texas *January, 1985*
Map No 1484-500-33


EXPLANATION
STUDY AREA
WILDLIFE MANAGEMENT REGIONS 1/
K A N S A S
MISSOURI
ARKANSAS
TEXAS
RED RIVER
CIMARRON
TEXAS
BEAVER
HARPER
WOODS
ALFALFA
GRANT
KAY
OSAGE
3
WASHINGTON
NOWATA
CRAIG
OTTAWA
ELLIS
WOODWARD
MAJOR
GARFIELD
NOBLE
PAWNEE
ROGERS
MAYES
DELAWARE
PAYNE
TULSA
WAGONER
CHEROKEE
ADAIR
DEWEY
BLAINE
KINGFISHER
LOGAN
CREEK
4
ROGER MILLS
CUSTER
CANADIAN
OKLAHOMA
5
LINCOLN
OKMULGEE
MUSKOGEE
SEQUOYAH
OKFUSKEE
McINTOSH
BECKHAM
WASHITA
CADDO
CLEVELAND
POTTAWATOMIE
SEMINOLE
HUGHES
HASKELL
GREER
KIOWA
GRADY
PITTSBURG
LATIMER
LE FLORE
HARMON
JACKSON
McCLAIN
GARVIN
PONTOTOC
COAL
1
COMANCHE
STEPHENS
MURRAY
TILLMAN
COTTON
CARTER
6
JOHNSTON
ATOKA
PUSHMATAHA
McCURTAIN
JEFFERSON
MAR-SHALL
BRYAN
CHOCTAW
LOVE
SCALE OF MILES
10 0 10 20 30 40 50
SCALE OF KILOMETERS
10 0 10 20 30 40 50

1/ NATIONAL HUNTING, FISHING, and WILDLIFE RECREATION SURVEY, U.S. FISH and WILDLIFE SERVICE, 1980

UNITED STATES
DEPARTMENT OF THE INTERIOR
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EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

RELATIONSHIP OF STUDY AREA TO WILDLIFE MANAGEMENT REGIONS
Amarillo, Texas *January, 1985*
Map No 1484-500-34

Table IV-3
Hunting and Fishing Supply, Demand, and Needs 1/
SCORP Regions 4 and 5
(East-Central Oklahoma Water Supply Study, January 1985)

	Fishing			Hunting		
	State	Region 4	Region 5	State	Region 4	Region 5
Supply						
Number of sites with activity	93	6	12	39	2	7
Total number of sites inventoried	920	85	61	920	85	61
Percent of sites with activity	10.1	7.0	19.6	4.2	2.3	11.4
Number of acres	505,067	93,835	29,307	537,445	73,241	32,085
Demand						
Total number of households participating	663,392	77,539	43,503	277,946	23,014	23,339
Participation rate	43	45	56	21	23	28
Activity occasions	28,412,439	3,465,059	2,418,793	5,972,628	532,656	659,122
Need						
Activity occasions	28,412,439	3,465,059	2,418,793	5,972,628	532,656	659,122
Number of acres	505,067	93,835	29,307	537,445	73,241	32,085
Required acres 2/	378,832	46,200	32,250	853,232	76,093	94,160
Relative adequacy 3/		10	5		9	3
Net acres needed	+126,235	+47,635	-2,943	-315,787	-2,852	-62,075

1/ Source: SCORP 1982.

2/ Based on 7 activity occasions per acre per year for hunting and 75 activity occasions per acre per year for fishing.

3/ The need for hunting and fishing acreage as compared to the other planning regions. The lower the number, the highest ranking of need among 11 SCORP regions.

- - - - - - - - - -

With these limitations, the SCORP projects a net need within Region 5 of 2,943 additional surface water acres for public fishing and 62,075 additional acres for public hunting. Region 4 has no net need for additional surface water fishing (primarily due to the influence of Lake Texoma) with a small net need for additional public hunting acreage (2,852 acres). The participation rate (demand) is higher for both hunting and fishing in these regions than for the State as a whole.

Table IV-4 presents statistical data extracted from the National Hunting and Fishing Survey. These data are again limited in usefulness for the study area due to regional overlapping and small samples used. The survey was conducted in 1981 and is based on participation by a selected sample of households in hunting, fishing, and other wildlife-oriented recreational areas during 1980. In Oklahoma, 2,260 households were screened and 600 sportsmen were interviewed in person. Sample sizes were designed to provide statistically reliable use data at the State level for fishing and hunting. Using Regions 4 and 5 as the most representative of fishing and hunting use in the study area, it can be seen that 26 to 30 percent of all resident hunting and fishing in the State occurs within the counties of these regions. About 10 to 13 percent of the nonresident hunting and fishing for the whole State occurred in these two regions. The dominant hunting activity in these two regions is small game. The 1980 survey extrapolated total participant resident hunters in the State at 315,800 compared with 280,253 in the 1982 SCORP. Total resident fishing participants were extrapolated to 769,100 as compared to 583,572 in the SCORP. The SCORP data includes only use of public facilities.

Certain data presented in the 1980 Hunting and Fishing Survey are not directly attributable to the study area since they were compiled only on a statewide basis. However, statewide data do provide some insight to the importance of consumptive hunting and fishing and use of public lands and waters. The average daily expenditure for a participant hunting in Oklahoma in 1980 was $26, of which about $7 was travel related. For fishermen, the average daily expenditure was $19, of which $7 was travel related. According to the survey, total expenditures for in-state activities were $359,417,300 for fishing and $165,330,700 for hunting in 1980.

Table IV-4
Fishing and Hunting by State Wildlife Management Region -
Population 16 years and older
(East-Central Oklahoma Water Supply Study, January 1985)

	State Total			Study Area Counties Within Region														
				Region 1 (Coal)			Region 3 (Pawnee)			Region 4 (Okfuskee, Seminole, and Hughes)			Region 5 (Lincoln, Pottawatomie, and Payne)			Region 6 (Pontotoc)		
Type of Sport	Participants	Days	Trips	Participants	Days	Trips	Participants	Days	Trips	Participants	Days	Trips	Participants	Days	Trips	Participants	Days	Trips
State Residents							(all numbers in hundreds)											
All fishermen	7,691	171,220	155,433	839	11,789	9,288	3,102	57,691	55,285	1,204	16,666	14,426	944	12,787	13,316	379	2,480	1,523
All hunters	3,158	60,826	60,542	610	7,534	6,531	889	14,418	13,993	415	7,138	7,085	476	4,049	4,125	127*	700*	615
Big game	1,657	11,410	9,558	406	1,900	1,102	414	2,909	2,707	216*	1,803*	1,700*	65	141	141	28	48	28
Small game	2,657	37,460	37,954	400	3,829	3,645	664	6,913	6,505	346	5,269	5,259	441	3,654	3,640	70	542	477
Migratory birds	879	7,452	7,333	69	965	965	207*	2,246*	2,246*	28	97	97	140*	344*	330*	29	104	104
Other hunting	509	5,666	5,697	77	891	820	147*	2,535*	2,535*	24	29	29	15	15	15	6	6	6
Nonresidents																		
All fishermen	2,403	18,682	14,411	342*	3,546*	2,688*	197*	1,427*	981*	97	244	128	229*	1,142*	1,185*	399	3,264	3,172
All hunters	406	3,485	3,752	52	390	261	63	984	973	0	0	0	39	155	220	17	101	50
Big game	88	291	118	13	73	13	6	17	6	0	0	0	0	0	0	0	0	0
Small game	307*	2,945*	2,050*	39	317	129	44	839	839	0	0	0	39	487	96	0	0	0
Migratory birds	49	452	419	0	0	0	13	128	128	0	0	0	6	124	124	17	67	34
Other hunting	83	1,512	1,166	30	149	119	0	0	0	0	0	0	0	0	0	17	34	17

Source: 1980 National Survey of Fishing, Hunting and Wildlife Associated Recreation, Oklahoma.

* Sample size less than 25 but greater than 10.

▭ Sample size less than 10.

Since there is only one major impoundment bordering the study area and only a limited number of small public lakes, much of the fishing activity is restricted to the larger streams and farm ponds on a widely dispersed basis. Within Oklahoma, about 36 percent of the fishermen utilized rivers and streams, 42 percent utilized small ponds or lakes (under 10 acres), and 73 percent utilized impoundments (greater than 10 acres). Also, based on the statistical survey, 42.9 percent of all Oklahoma hunters utilized public land, primarily for deer, small game, and waterfowl. Within the study area, hunting and fishing activity is largely restricted to private lands since there are few public (State/Federal) areas available.

D. Special Need for Additional Study Planning Activities

Previous discussions in this chapter have referred to the fact that existing State and Federal recreational developments are clustered around Keystone Lake in the extreme northeast of the study area and Planning Region 5 as well as around Lake Texoma south of the study area in the southern portion of Planning Region 4. Further investigation of distribution of these facilities on a statewide basis again shows a fairly reasonable distribution of recreation facilities in most areas of the State; the most notable exception is the study area, especially when its sizeable population is considered. This situation can be readily seen in map No. 1484-500-35. The significance of what one sees on the map is that summary data for the State or the planning regions may reflect an ample supply of regional facilities for certain recreational activities, but there may be more localized needs which are not addressed. This fact is abundantly clear to a family residing in the middle of the study area when they have to travel 80 or more miles across several counties to use these facilities.

All ongoing or future studies in this area should recognize, assess, and plan for hunting, fishing, recreation, and tourism facility needs on a localized basis as well as an overall regional basis.

E. Regional Outdoor Recreation Facility Needs

The SCORP Planning Region 5 (COEDD) includes all but the two most southerly study area counties. As shown previously on map No. 1484-500-33, nearly all of the State and Federal recreational facility developments are concentrated around Keystone Lake in the extreme northeast of the study area. Although Region 5 has less than 2 percent of the State's total parkland, it is relatively well developed in terms of regional analysis of recreation facility needs. The most significant facility needs in the region are for golf, baseball, picnicking, and hunting as shown in table IV-5.

Table IV-5
Outdoor Recreation Facility Needs
in Planning Region 5 (COEDD) 1/
(East-Central Oklahoma Water Supply Study, January 1985)

Activity	Unit of Measurement	Facilities Required	Facilities Existing	Facilities Needed 2/	Relative Adequacy 3/
Backpacking	Trail miles	8	13	+ 5	6
Baseball	Diamonds	178	64	- 114	3
Biking	Trail miles	633	26	- 607	7
Canoeing	Trail miles	0	0	0	7
Fishing	Water acres	32,250	29,307	- 2,943	5
Golfing	Holes	466	54	- 412	3
Hiking	Trail miles	6	13	+ 7	9
Horseback riding	Trail miles	370	12	- 358	5
Hunting	Acres	94,160	32,085	- 62,075	3
Motor boating	Water acres	2,265	29,285	+ 27,020	7
Picnicking	Picnic tables	1,568	321	- 1,247	3
Sailing	Water acres	0	29,285	+ 29,285	6
Softball	Diamonds	53	47	- 6	11
Swimming	Pools	198	18	- 180	6
Tennis	Courts	124	117	- 7	8
Tent camping	Sites	120	630	+ 510	10
Vehicle camping	Sites	142	155	+ 13	5
Waterskiing	Water acres	1,220	29,285	+ 28,065	8

1/ Source: 1982 SCORP.
2/ (-) Indicates level of need.
(+) Indicates surplus level.
3/ 's compared to other planning regions:
(1) Indicates the highest level of need of all planning regions.
(11) Indicates the lowest level of need of all planning regions.

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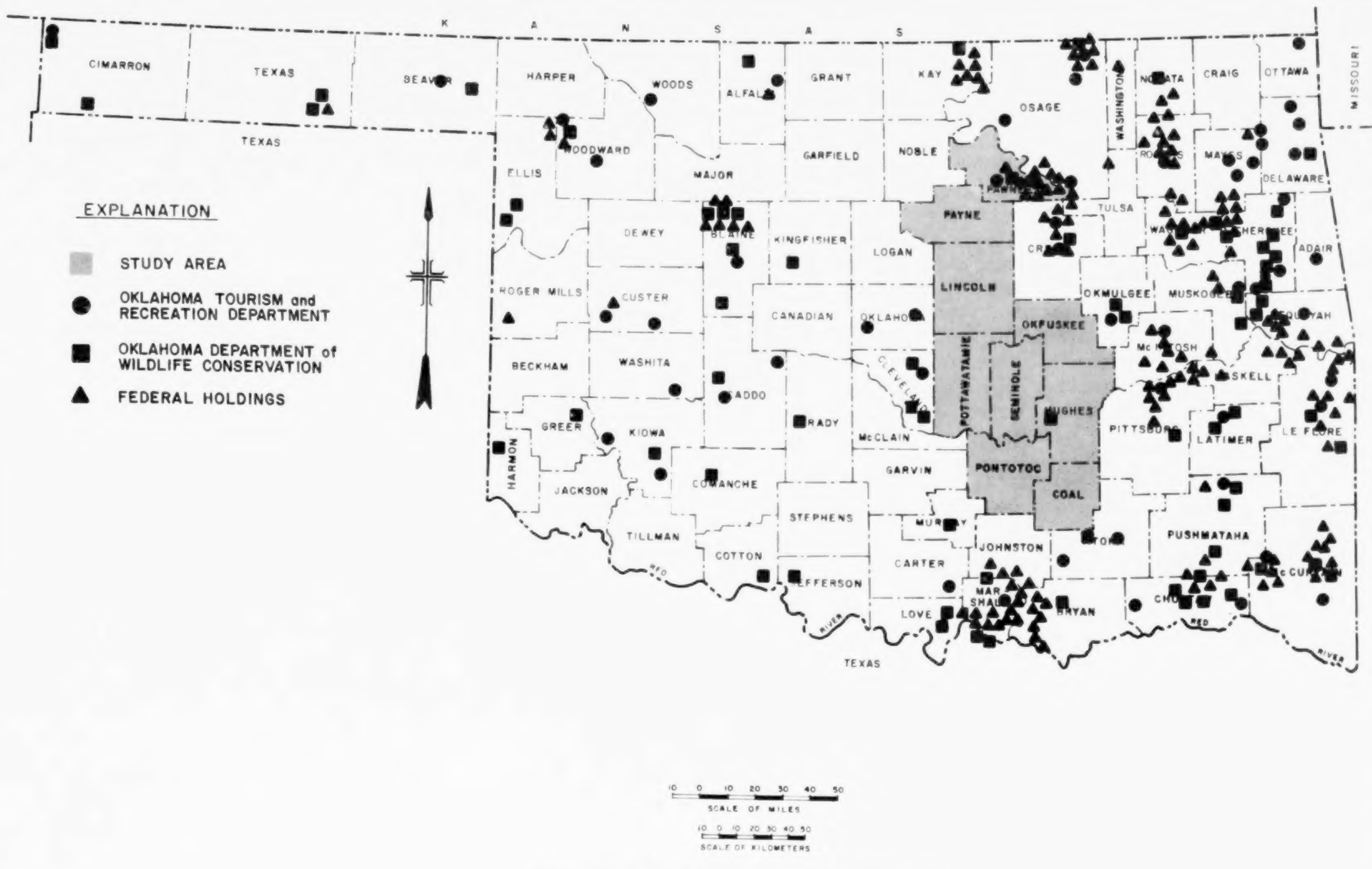
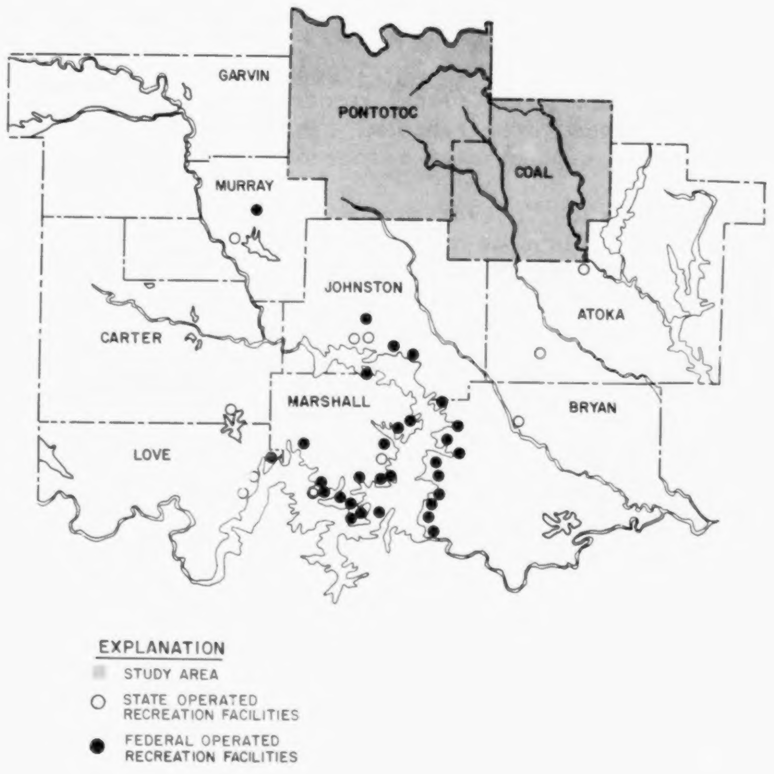
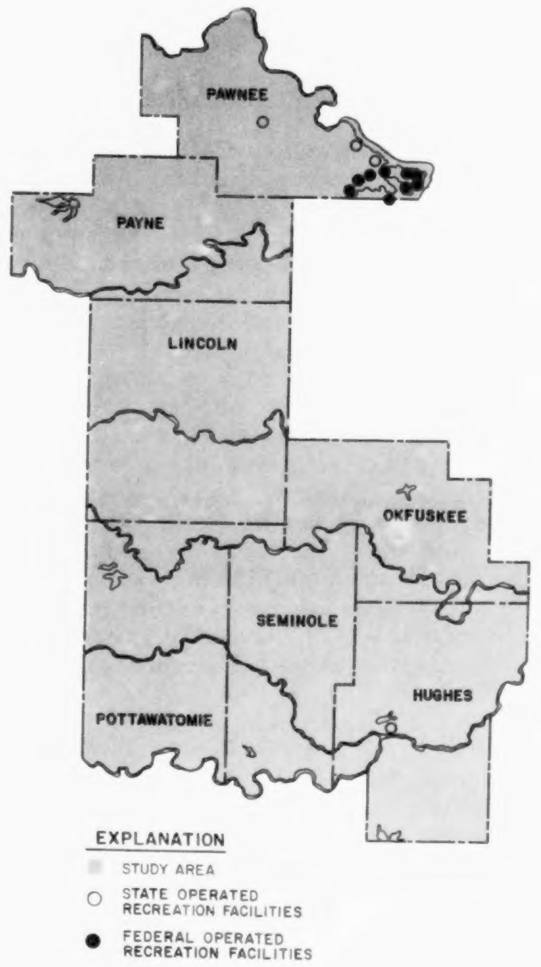

K A N S A S
CIMARRON
TEXAS
BEAVER
HARPER
WOODS
ALFALFA
GRANT
KAY
OSAGE
NOWATA
CRAIG
OTTAWA
MISSOURI
WASHINGTON
ROGERS
MAYES
DELAWARE
WOODWARD
ELLIS
MAJOR
GARFIELD
NOBLE
PAWNEE
PAYNE
TULSA
WAGONER
CHEROKEE
ADAIR
DEWEY
BLAINE
KINGFISHER
LOGAN
CREEK
LINCOLN
OKMULGEE
MUSKOGEE
SEQUOYAH
ROGER MILLS
CUSTER
CANADIAN
OKLAHOMA
OKFUSKEE
McINTOSH
HASKELL
BECKHAM
WASHITA
CADDO
CLEVELAND
POTTAWATOMIE
SEMINOLE
HUGHES
PITTSBURG
LATIMER
LE FLORE
GREER
KIOWA
GRADY
McCLAIN
HARMON
JACKSON
COMANCHE
GARVIN
PONTOTOC
COAL
TILLMAN
STEPHENS
MURRAY
ATOKA
PUSHMATAHA
COTTON
JEFFERSON
CARTER
JOHNSTON
McCURTAIN
LOVE
MARSHALL
BRYAN
CHOCTAW
RED RIVER
TEXAS
ARKANSAS
EXPLANATION
STUDY AREA
OKLAHOMA TOURISM and RECREATION DEPARTMENT
OKLAHOMA DEPARTMENT of WILDLIFE CONSERVATION
FEDERAL HOLDINGS
10 0 10 20 30 40 50
SCALE OF MILES
10 0 10 20 30 40 50
SCALE OF KILOMETERS

RECREATION AREAS IN OKLAHOMA
(SCORP 1982)


GARVIN
PONTOTOC
COAL
MURRAY
JOHNSTON
ATOKA
CARTER
MARSHALL
BRYAN
LOVE
EXPLANATION
STUDY AREA
STATE OPERATED RECREATION FACILITIES
FEDERAL OPERATED RECREATION FACILITIES

RECREATION AREAS IN SCORP REGION # 4


PAWNEE
PAYNE
LINCOLN
OKFUSKEE
SEMINOLE
HUGHES
POTTAWATOMIE
EXPLANATION
STUDY AREA
STATE OPERATED RECREATION FACILITIES
FEDERAL OPERATED RECREATION FACILITIES

RECREATION AREAS IN SCORP REGION # 5

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY
ABSENCE OF RECREATION DEVELOPMENT
IN MOST OF STUDY AREA
(STATEWIDE & PLANNING DISTRICTS)
Amarillo, Texas November, 1984
Drawing No. 1484-500-35

The SCORP Planning Region 4 (SODA) comprises a 10-county area, of which only 2 are included in the study area (Pontotoc and Coal). Region 4 is considered the best developed area in the State in terms of satisfying total recreational needs, which is primarily due to recreational development in and around the Lake Texoma area. On a regional basis, increased canoeing, hiking, and recreational vehicle (RV) camping facilities are the only significant needs identified. Region 4 recreation facility needs are displayed in table IV-6.

Table IV-6
Outdoor Recreation Facility Needs
in Planning Region 4 (SODA) 1/
(East-Central Oklahoma Water Supply Study, January 1985)

Activity	Unit of Measurement	Facilities Required	Facilities Existing	Facilities Needed 2/	Relative Adequacy 3/
Backpacking	Trail miles	3	11	+ 8	7
Baseball	Diamonds	114	44	- 70	7
Biking	Trail miles	481	2	- 479	11
Canoeing	Trail miles	1	0	- 1	2
Fishing	Water acres	46,200	93,835	+ 47,635	10
Golfing	Holes	118	37	- 81	10
Hiking	Trail miles	35	11	- 24	2
Horseback riding	Trail miles	359	15	- 344	7
Hunting	Acres	76,093	73,241	- 2,852	9
Motor boating	Water acres	9,559	89,469	+ 79,910	10
Picnicking	Picnic tables	1,182	1,945	+ 763	10
Sailing	Water acres	473	89,469	+ 88,996	10
Softball	Diamonds	62	52	- 10	10
Swimming	Pools	171	17	- 154	7
Tennis	Courts	64	101	+ 37	10
Tent camping	Sites	592	698	+ 106	8
Vehicle camping	Sites	1,453	759	- 694	2
Waterskiing	Water acres	5,035	89,469	+ 84,434	11

1/ Source: 1982 SCORP.
2/ (-) Indicates level of need.
(+) Indicates surplus level.
3/ As compared to other planning regions:
(1) Indicates the highest level of need of all planning regions.
(11) Indicates the lowest level of need of all planning regions.

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F. Problems, Needs, and Opportunities

In summary, regional analyses of the study area indicate a range of priority needs for golfing, baseball, picnicking, hunting, canoeing, hiking, and RV camping facilities development. Nearly all of the nine-county study area has no easily accessible State or Federal recreation facility development. Ongoing investigations should recognize and address these regional recreational needs as well as localized needs which may be satisfied through multipurpose water resource development.

Federal agencies presently control more than 50 percent of all public lands in Oklahoma, with about half of this acreage administered by the Corps in major water resource projects. Reclamation and U.S. Forest Service also provide substantial publicly owned acreage in Oklahoma. About 42 percent (over 307,000 acres) of the total lands managed by the ODWC Game Division was obtained through license of lands acquired for Federal water resource development projects. In addition, all six national wildlife refuges operated by the FWS in Oklahoma were obtained through multipurpose water resource development. The Federal Government, therefore, has had a major role in providing public outdoor recreation and lands for fish and wildlife purposes. Within the East-Central Oklahoma Study area, however, there is presently only one federally owned project providing public recreational opportunity such as fishing or hunting (Keystone Lake). The role of Federal water resource agencies is to (1) provide protection for environmental and recreational resources of identified national significance, (2) preserve outstanding natural areas, and (3) provide for outdoor recreation opportunity on existing or proposed Federal land and water resource projects.

The State also has a role in environmental quality and provision of outdoor recreation opportunities. Responsibilities include acquiring, protecting, and developing the State's natural resources into a system of parks, forests, natural areas, wildlife management areas, reservoirs, landmarks, trails, and scenic rivers. To accomplish this, the State has a planning and coordination responsibility both upward through Federal activities and downward through local government and nongovernment activities to cooperatively achieve a coordinated development plan.

With ultimate development of both economic resources and supportive water resources within the east-central Oklahoma region, the roles of both Federal and State agencies should be one of avoidance or protection of sensitive environmental resources at the national and State level of significance and incorporating into development plans those provisions which will preserve, enhance, or create opportunities for public use of natural resources.

The State of Oklahoma, and in particular southeast Oklahoma, has a good outdoor recreational resource base. The vast majority of the Federal and State recreational holdings within Oklahoma have been acquired as a direct result of past water resource development and are clustered around impoundments. The State of Oklahoma has utilized the opportunities afforded by multiple-use development of water resources to obtain and manage numerous areas for public outdoor recreation, including hunting and fishing. Federal agencies, particularly the Corps and Reclamation, have also provided recreational facilities, public hunting areas, and preserves in the form of refuges and natural areas on existing water resource projects.

The study area is undeveloped in terms of major impoundments, with most existing water-oriented recreation resources located to the east, southeast, and south. However, major recreational areas available outside the east-central region are often underutilized. All of southeast Oklahoma is within tourism range of the major market areas of Oklahoma City and Tulsa, Oklahoma, and Dallas and Fort Worth, Texas. Therefore, additional facility development within the east-central resource area may serve primarily to transfer existing use to new lakes without any significant overall increase use and economic benefits to the larger region. However, additional water resource development within the study area would serve to increase the local recreational resource base. New reservoirs also offer an opportunity for optimum natural resource preservation and recreational development not usually possible on older existing reservoirs.

In conjunction with any proposed water resource development, opportunities exist to preserve or enhance wildlife habitat through land acquisition of areas needed for project operation, mitigation land, recreation areas, or environmental quality features. While these lands are small and restricted to the vicinity of the projects, they can provide publicly accessible fishing and hunting areas to satisfy needs identified in the SCORP. There is an identified need for additional water acreage for public fishing in this area, which is relatively unique among SCORP recreation regions.

CHAPTER V - ENVIRONMENTAL RESOURCES 1/

A. Vegetational Resources

The game-type habitat map prepared by Duck and Fletcher (1943) divides the vegetation of the State of Oklahoma into 14 major historical associations. However, within the study area, three major types occur. These are the post oak-blackjack oak forest, the tallgrass prairie, and the bottom land (flood plain) forest. The eastern oak-hickory forest barely extends into the extreme eastern portions of Okfuskee and Hughes Counties.

1. Post oak-blackjack oak forest. This association is by far the most extensive type within the east-central resource region as well as the type covering the most land area within the State. It is an upland forest type, occurring in a drier climatic zone than the eastern woodland deciduous forests to the east (such as the oak-hickory and oak-pine forests). The number of woody forest species is greatly reduced due primarily to the less favorable moisture conditions. Dominant tree species are post oak, blackjack oak, and black hickory. Persimmon and various hackberries are also common. Frequent small tree and understory plants include chittamwood, Mexican plum, dogwood, Southern blackhaw, and coral berry. Herbaceous plants within the upland forest is not notably diverse. Much of the original upland forest has been cleared in small tracts or blocks for agricultural use (primarily for grazing). This type presently has limited commercial forest value but has relatively high value as wildlife habitat, particularly when associated with agricultural fields or bottom land hardwood forests. Most of the forested area is privately owned and in small tracts.

2. Tallgrass prairie. Within the east-central resource region, almost all the upland area not forested with the post oak-blackjack oak association was once tallgrass prairie. While the tallgrass prairie becomes the dominant vegetation association immediately to the north and west of the study area counties, within the east-central region it is historically restricted to several large blocks where soil conditions were more favorable to grassland development than forest. It is also the vegetation type found in clearings and savannah situations throughout the upland forest areas. Dominant native grasses in the association are big bluestem, little bluestem, Indiangrass, and switchgrass. Characteristic shrubs include lead plant, dwarf chinquapin oak, and Chickasaw plum. Many herbaceous species are present, particularly on disturbed areas. Due to favorable soil characteristics, most of the tallgrass prairie has been converted to agricultural use within the study area.

3. Bottom land (flood plain) forest. This vegetation association is highly variable in species composition and areal extent throughout the State. Major rivers trend east-west or northwest-southeast within Oklahoma, causing this association to be found crossing many of the other vegetational types (which broadly occur in north-south bands due to the reduction in precipitation from east to west). Within the study area, the bottom land association occurs principally along the flood plains of the Canadian and North Canadian Rivers, Cimarron River, Deep Fork River, Clear Boggy Creek, Muddy Boggy Creek, and larger tributary streams. While the areal extent of this vegetation type is small in comparison to other associations, it is important for several reasons. The combination of alluvial soils and high moisture regime along the flood plains allows eastern woodland species to populate these corridor areas much farther to the west than they normally would occur. This provides a mixing and extension of eastern woodland habitats into the western prairie regions, which creates a diversity of plant species and associated wildlife. The bottom land types are essential corridors for the movement of many austroriparian (eastern) species into the more western areas of the State. Black willow, cottonwood, western soapberry, American elm, and ash dominate in the western areas of the region, with gradation to more eastern bottom land species such as various oaks, sycamore, and pecan-walnut-hickory in the eastern counties of the study area. Where protection from flooding occurs, much of the bottom land wooded area within the region has been partially or completely cleared for agricultural use and hardwood timber.

Along tributary streams which have no well-developed flood plain or in regrowth areas of former bottom land forest, a subtype of the bottom land forest occurs. This growth has been termed riparian, which denotes habitat along streams and transitional to either the bottom land forest, upland areas, or both. Since the riparian vegetation blends with other habitats, it provides habitat diversity and supports a wide variety of both plant and animal species (USDI 1984).

Within the bottom land vegetative association are also found wetland types of the Riverine and Palustrine systems. The bottom land wooded areas fall primarily within the Palustrine deciduous forested wetland class, with scrub-shrub wetlands and emergent wetlands also present (Cowardin et al. 1979). Bottom land wooded/wetland areas of large size are known to exist along the Deep Fork and North Canadian Rivers in Okfuskee County.

B. Fish and Wildlife Resources

The eastern deciduous forests of the United States reach their westernmost limits in central Oklahoma. Similarly, the western grassland and prairies meet their easternmost limits here also. Consequently, a large number of wildlife species occur within the study area representing both the eastern and western states' animal assemblages. However, due to the fact that these species are on the edge of their suitable range, populations may not be great.

1/ For references, see section at end of report.

1. Mammals. Several species of bats, the eastern mole, armadillo, opossum, several shrews, numerous rodents, and several species of skunks and rabbits represent the small mammal assemblage in the study area. Larger mammals include the whitetail deer, raccoon, bobcat, gray fox, and beaver in woodland areas and along streams and the coyote and badger in prairie areas. Principal game mammals are the whitetail deer, fox squirrel, and cottontail rabbit. The eastern chipmunk and eastern woodrat reach their western limit in the area and the kangaroo rat, grasshopper mouse, and jackrabbit near their eastern limits.

2. Birds. Bird species commonly associated with the post oak-blackjack oak-tallgrass prairie vegetative associations are the turkey vulture, broad-winged hawk, barred owl, hairy woodpecker, eastern wood pewee, tufted titmouse and Carolina chickadee on woodland areas; and red-tailed hawk, killdeer, mourning dove, flicker, scissor-tailed flycatcher, eastern kingbird, eastern meadowlark, dickcissal, and lark sparrow on prairie or savannah habitats. Resident upland game birds include bobwhite quail and wild turkey. Migratory birds include many species of ducks, geese, and shorebirds utilizing the Central Flyway and the mourning dove. Many of these species are classified as migratory game. Again, many species of birds are on the edge of their eastern or western range limits in the central Oklahoma region.

3. Reptiles and amphibians. The reptiles and amphibians of east-central Oklahoma represent another interface between eastern and western forms. The majority of amphibians, and many reptilian species, are limited to areas near water (ponds, rivers, streams, or lowland areas). Representative reptiles include the snapping turtle, red-eared turtle, yellow and Mississippi mud turtle, three-toed and ornate box turtle, six-lined racerunner, eastern-collared lizard, several species of skinks and fence lizards, eastern yellow-bellied racer, rat snakes, hognose snake, and several species of kingsnakes, coach whips, garter snakes, and water snakes. Poisonous snakes found in east-central Oklahoma include the copperhead, cottonmouth, and several species of rattlesnakes. Spadefoot toads, Rocky Mountain toad, Upland and Strecker's chorus frogs, Great Plains toad, bullfrog, leopard frog, and several species of salamanders are representative amphibians.

4. Fish. The study area includes drainage areas of both major river systems found in Oklahoma, the Arkansas and Red Rivers. From a fisheries viewpoint, the nine-county area is unique in Oklahoma in that the area is almost devoid of major impoundments. Manmade reservoir development in Oklahoma has had a profound influence on fish distribution and abundance. However, within the study area, there are no impoundments on the major streams and only a few small impoundments (generally less that 1,000 acres) on tributary streams. Keystone Lake on the Arkansas River bordering Pawnee County, is the only major impoundment and is only partially within the study area. Therefore, the fish species present and population status are more dependent on the natural fluctuations and permanency of flow within the river systems, quality of water, and exotic introductions. Common river species include gizzard shad, fathead minnow, sand shiner, red shiner, river carpsucker, bullhead and channel catfish, green sunfish, and bluegill. Species occurring primarily in lakes and ponds, but also occurring in rivers in the region, include the largemouth bass, white crappie, warmouth, carp, buffalo, freshwater drum, and white bass. Some, but not all of the riverine species previously listed, also do well in impoundments.

C. Threatened or Endangered (T or E) Species

There are no federally listed T or E mammals, reptiles, amphibians, or fish with a known range in the nine counties of the East-Central Oklahoma Study area. There are three migratory (or wandering) bird species which possibly could be found in the study area at certain times of the year. The whooping crane migrates through Oklahoma in spring and fall, and the study area is on the eastern fringe of the migratory corridor. The American peregrine falcon (Falco peregrinus anatum) has been recorded in southeast-central Oklahoma during winter migrations. The bald eagle (Haliaeetus leucocephalus) is a winter resident in Oklahoma but is not commonly found in the study area. These two species are usually associated with major impoundments. Bald eagle concentrations occur annually at Keystone Lake and on the Arkansas River, with occasional sightings elsewhere in the study area. The interior least tern (Sterna antillarum athalassos) was proposed for listing as federally endangered on May 29, 1984. This species breeds irregularly and locally on sandbars, riverbeds, and barren shores of impoundments throughout Oklahoma.

Oklahoma does not have an official State list of endangered species. An informal listing (Lewis et al. 1975) of State species of concern is used as a general guide for identifying sensitive species. However, this listing is strictly unofficial and species so listed do not have any formal State or Federal protection except through the wildlife laws of the State of Oklahoma or indirect Federal statutes. The ODWC administers to these species under its general mandate to manage all fish and wildlife resources of the State. Species recorded in this informal listing and possibly occurring within the study area are listed in table V-1.

There are no federally listed T or E plants occurring in the study area or in Oklahoma. There are a number of candidate species under Federal review for potential listing. None of those species have any official status at this time, though they should be considered in planning activities to avoid potential future conflicts. A number of listings of plants which may be endangered or threatened have been compiled from 1975 to 1983 and used in reviews conducted by FWS. These include reports by the Smithsonian Institution (1975), Ayensu and DeFilipps (1978), and listings of species under review published in the Federal Registers of December 15, 1980, and November 28, 1983. Data on endangered plants in Oklahoma were published by Zanoni et al. 1979. Two species included on Federal review lists and on the latter reference list (Alnus maritima - seaside alder, and Vicia reverchonii - hairy podvetch) are noted from counties in the study area. Both of these species are no longer under review for Federal listing (Federal Register, December 15, 1980). Definitive range studies on other species of plants which are under review and may possibly occur with the study area have not been conducted.

Table V-1
State Sensitive Wildlife Species 1/
East-Central Oklahoma
(East-Central Oklahoma Water Supply Study, January 1985)

Common Name	Scientific Name	Remarks
State Endangered 2/		
Swamp rabbit	*Silvilagus aquaticus*	Game species with hunting season
River otter	*Lutra canadensis*	Extant in Le Flore County (unlikely to occur)
Cougar	*Felis concolor*	Okfuskee County Historic Record
Bald eagle	*Haliaeetus leucocephalus*	Federally endangered
Peregrine falcon	*Falco peregrinus*	Federally endangered
Swallow-tailed kite	*Elanoides forficatus*	Wooded areas (west to Woodward County) may no longer occur in State
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	Eastern Oklahoma only
State Rare - 1 2/		
Desert shrew	*Notiosorex crawfordi*	Southwest of line, Harper to Pushmataha County
Golden eagle	*Aquila chrysaetus*	Small numbers in Central Oklahoma
Scarlet snake	*Cemophora coccinea*	Seminole County Record
Pallid shiner	*Notropis amnis*	Red River system west to Clear Boggy Creek, also in Arkansas system
River shiner	*Notropis blennius*	Arkansas and Red Rivers, major tributaries
State Rare - 2 2/		
Ringtail	*Bassariscus astutus*	Pontotoc County Record
Night snake	*Hypsiglena ochrorhynca*	Pontotoc County westward
Hurter's spadefoot	*Scaphiopus hurteri*	Eastern one-half of Oklahoma
Least darter	*Etheostoma microperca*	Spring-fed streams - Blue River and Eastern Arkansas drainage
Highfin carpsucker	*Carpiodes velifer*	Larger streams, Arkansas and Red River drainages
Status Undetermined 2/		
Goldeye	*Hiodon alosoides*	Impoundments, Arkansas and Red River drainage (west to Ft. Cobb Lake)
Least tern	*Sterna antillarum*	Proposed federally endangered

1/ Source: *Rare and Endangered Vertebrates and Plants of Oklahoma*, Lewis et al., 1975.
2/ Key to Categories:

Endangered - Threatened with extinction in State. May be abundant elsewhere.
Rare 1 - Not presently threatened with extinction but found in small populations within the State.
Rare 2 - May be abundant in certain areas but has restricted range within State.
Status Undetermined - Suggested as rare or endangered but insufficient information to confirm status.

D. Unique and Sensitive Environmental Areas

The nine-county study area includes one State recreation area (Feyodi Creek, Keystone Lake) and one State wildlife management area (Keystone), both in Pawnee County. The ODWC operates a fish hatchery at Holdenville in Hughes County. The Corps also provides Federal recreation facilities and public hunting areas on Keystone Lake.

The headwaters of the Blue River extend to near Roff in southern Pontotoc County. This river was identified in the Natural Rivers Inventory (Natural and Free-flowing Phase) compiled by the Heritage and Conservation Service, now a part of the National Park Service (USDI 1982). The Blue River has a total length of about 128 miles in Bryan, Johnston, and Pontotoc Counties with about 20 miles within the study area.

The inventory process was a first phase to identify river segments which remain relatively free flowing and undeveloped for potential inclusion in the National Wild and Scenic Rivers System under section 2, Public Law 90-542. However, inclusion of rivers on the Phase 1 list does not mean that all or any of the rivers so identified would be ultimately included in the national system. The second phase of the inventory process remains uncompleted (study for actual listing potential). The Blue River was also studied for potential State listing as a scenic river under the State Scenic Rivers Act (82 O.S. Supp. 1979, section 1452)(OTRD 1982). However, at the present time, it has no official protected status under either State or Federal legislation.

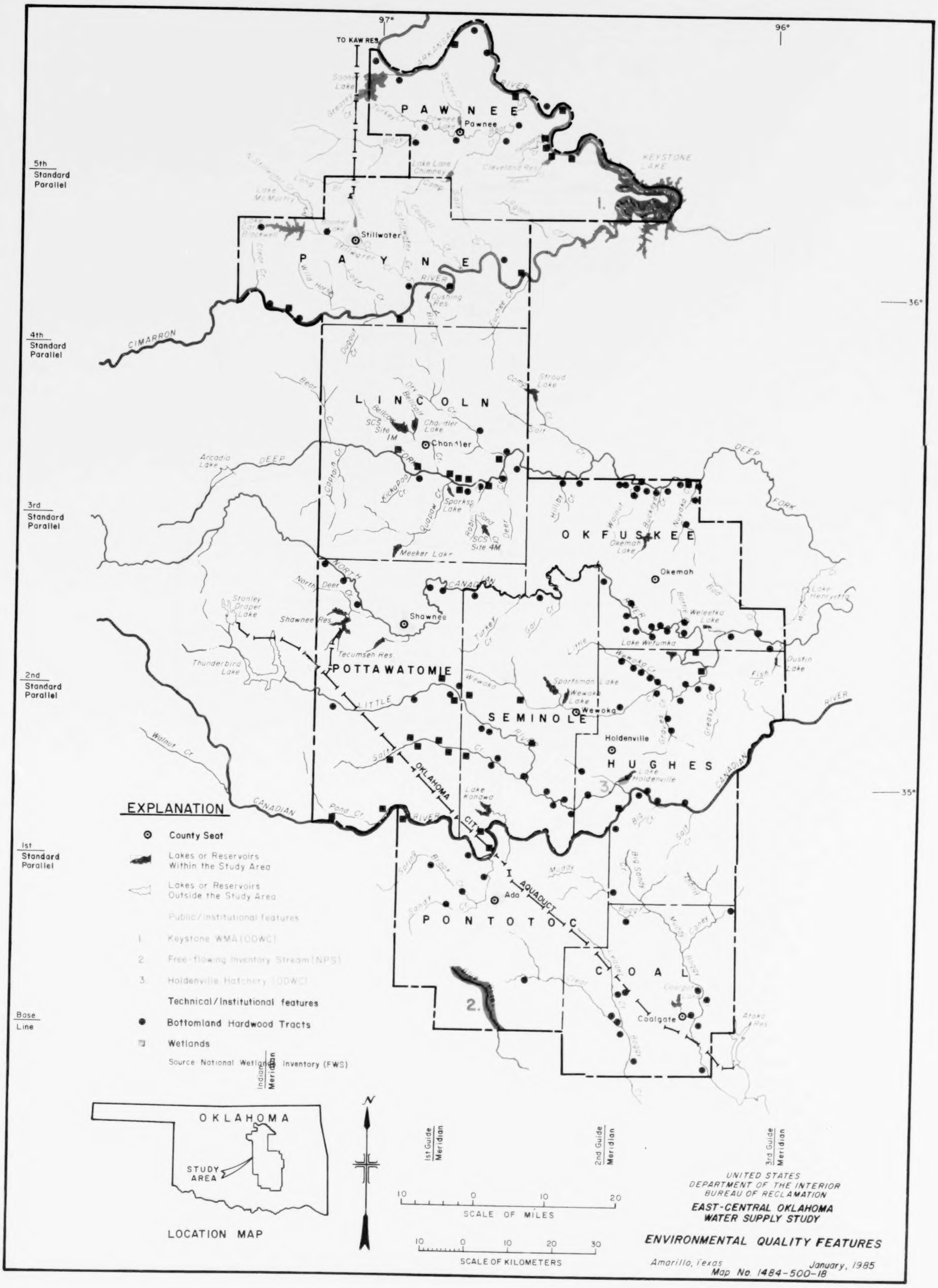
Additional nonpublic resources which are considered environmentally sensitive include wetlands, riparian and bottom land forests, remaining native prairie areas, and stream habitats. The more significant of these features and the above-described environmental areas are displayed on map No. 1484-500-18. These resources are important to fish and wildlife because they are usually highly productive, support a diversity of both plant and animal species, are limited in extent, and have been extensively modified through land use change and water resource development. The Oklahoma Natural Heritage Program has identified several tracts of post oak/blackjack oak forest, bottom land hardwoods, and native tallgrass prairie within the region which should be preserved. At least five tracts identified in the inventory process occur within the study area (one each in Pontotoc, Coal, Seminole, Lincoln, and Pawnee Counties). Exact locations of these tracts are available from the Oklahoma Tourism and Recreation Department (OTRD). Nearly all perennial and intermittent streams within the study area support some flood plain vegetative communities important to fish and wildlife. Wetland areas are provided a degree of protection through provisions of section 404 of the Clean Water Act (Public Law 95-217) as they relate to water quality maintenance and the overall public interest. Wetland areas and bottom land hardwoods of considerable extent occur in overflow areas along the Deep Fork River in Lincoln and Okfuskee Counties. The FWS has identified these areas as environmentally important though there are many other smaller areas within the region which may be equally important locally (USDI 1984).

Created wetlands occur along much of the Deep Fork in eastern Lincoln County as a result of past agricultural development of the flood plain.

Shallow manmade impoundments along the Deep Fork provide wetland-wildlife habitat during nonflood stages.

E. Problems and Needs

The nine-county study area is almost totally rural in nature and notably lacking in presently identified unique, sensitive, or public environmental resources of national or regional significance. Noted environmental problems relate more to a trend of general wildlife habitat loss and water quality-streamflow regulation problems than to environmental resources given specific protection by Federal or State law. There are no federally listed endangered or threatened species (except for migrants) and a limited number of existing publicly owned resources of an environmentally sensitive nature. However, the area lies on the fringes of the Oklahoma City and Tulsa metropolitan areas, is crossed by major interstate access routes (I-40 and I-44), and has great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LINCOLN
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Okemah
POTTAWATOMIE
Shawnee
SEMINOLE
Wewoka
HUGHES
Holdenville
PONTOTOC
Ada
COAL
Coalgate
ARKANSAS RIVER
CIMARRON RIVER
DEEP FORK
NORTH CANADIAN
LITTLE RIVER
CANADIAN RIVER
Sooner Lake
Greasey Cr
Turkey Cr
Skedee Cr
Pawnee Lake
Bear Cr
Black Bear Cr
Hellroaring Cr
Cleveland Res.
Keystone Lake
Lake Lone Chimney
Camp Cr
Salt Cr
Lagoon Cr
Stillwater Cr
Long Br
Lake McMurtry
Lake Carl Blackwell
Boomer Lake
Council Cr
Clear Cr
Wild Horse Cr
Lost Cr
Cushing Res.
Big Cr
Euchee Cr
Dugout Cr
Bear Cr
Dry Bellcalf Cr
Bellcow Cr
SCS Site 1M
Chandler Lake
Stroud Lake
Arcadia Lake
Captain Cr
Kickapoo Cr
Quapaw Cr
Sparks Lake
Rock Cr
Deer Cr
SCS Site 4M
Meeker Lake
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Lake Henryetta
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Thunderbird Lake
Shawnee Res.
Tecumseh Res.
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Turkey Cr
Gar Cr
Sportsman Lake
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Wewoka Cr
Graves Cr
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Lake Holdenville
Walnut Cr
Salt Cr
Pond Cr
Lake Konawa
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Atoka Res.
OKLAHOMA CITY AQUADUCT
1.
2.
3.
EXPLANATION
⊙ County Seat
Lakes or Reservoirs Within the Study Area
Lakes or Reservoirs Outside the Study Area
Public/Institutional features
1. Keystone WMA (ODWC)
2. Free-flowing Inventory Stream (NPS)
3. Holdenville Hatchery (ODWC)
Technical/Institutional features
● Bottomland Hardwood Tracts
▨ Wetlands
Source National Wetlands Inventory (FWS)
OKLAHOMA
STUDY AREA
LOCATION MAP
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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

ENVIRONMENTAL QUALITY FEATURES

Amarillo, Texas January, 1985
Map No. 1484-500-18

potential for future economic development. Land use changes, due to agricultural, mineral, or industrial development, have modified much of the presettlement wildlife habitat within the region. Surface water pollution from oilfield brine disposal and urban effluent has affected and will probably continue to affect the species assemblages and productivity of area streams. Potential water resource development may cause additional losses of important fish and wildlife habitats but also may provide the means for preservation or restoration of modified habitat through multiple resource development and management.

Opportunities for conservation of endangered/threatened species in accordance with the Endangered Species Act may also be realized with Federal water resource development within the study area. Bald eagles concentrate during winter around major rivers and large impoundments. They are particularly attracted to areas where large roughfish populations or waterfowl occur. Water resource development may provide additional overwintering roost areas for this species in association with new impoundments. The interior least tern (proposed endangered) utilizes barren shorelines of major impoundments and also sandbars in major rivers. Water resource development may provide opportunities to develop additional nesting colony habitat for this species through reservoir development or river regulation to maintain barren sandbar habitat. Creation or maintenance and protection of wetland areas in association with the major rivers or any proposed new impoundments may also provide additional means of conservation to the whooping crane population, which utilizes the study area in isolated instances.

F. Environmental Impact Considerations

Site-specific environmental studies must be conducted for any new proposed water resource development within the east-central resource area. Until studies are conducted (along with engineering and economic feasibility studies), environmental concerns, impacts, and opportunities can be addressed only at the generic level.

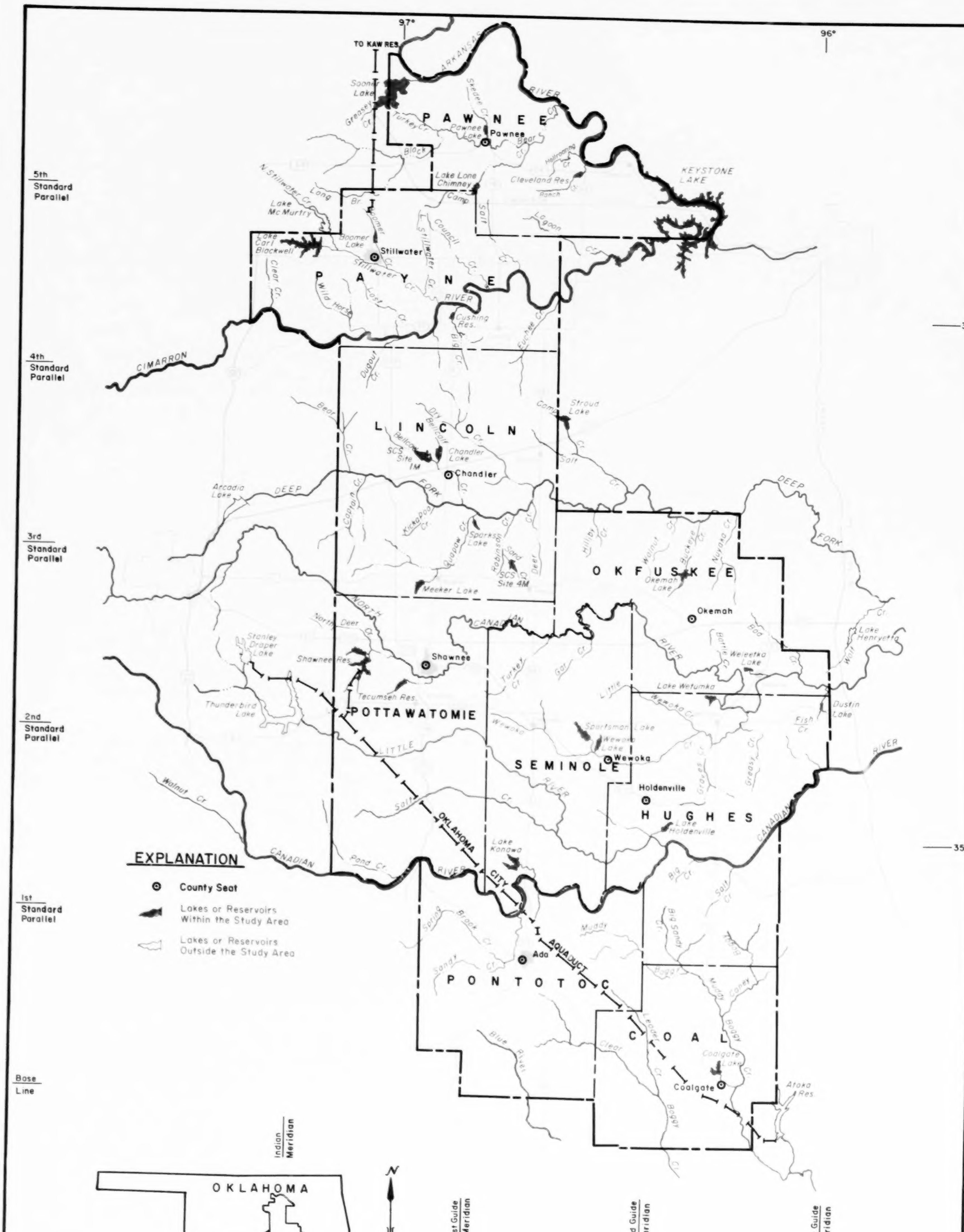
Construction of any proposed new reservoirs will result in losses of terrestrial wildlife and stream fishery habitats. As a partial tradeoff, lake aquatic habitat will be gained. Changes in streamflow regulation and development of water supply yield will affect downstream aquatic resources and have potential to affect the quality and quantity of downstream wetlands, bottom land hardwoods, and riparian habitats due to changes in flooding patterns or induced land use changes. The latter indirect impacts may be either adverse or beneficial, depending on the quality of the existing resources and the operational features incorporated into reservoir regulation plans. The significance of the losses and the potential to offset the losses through habitat mitigation depends on the quantity and quality of the resource lost, its value to fish and wildlife, and its scarcity or replaceability. Site-specific impacts on uniquely productive wetland areas, bottom land or riparian habitats, native prairie, or valuable stream reaches cannot be fully determined without specific studies in proposed reservoir sites.

None of the potential damsites identified for possible future water resource development in the east-central Oklahoma region would affect any rivers included in either State or Federal wild and scenic rivers inventories. None of the potential damsites identified would be located in the vicinity of any existing State or Federally operated parks, recreation areas, wildlife management areas, refuges, or other presently recognized sensitive publicly owned resources.

Endangered species of possible occurrence along the streams of the study area include the bald eagle and whooping crane, neither year-round residents. The interior least tern, a species proposed for endangered status, is also possible in the study area. No Federally listed, T or E plant species occur in the region nor are any species presently under review for listing known to occur in the counties of the study area. No specific range studies have been conducted to determine the probability of occurrence in the study area of any species under review.

General terrestrial habitat which would be inundated by any new reservoir project in the east-central region would include bottom land hardwood and riparian, upland post oak-blackjack oak woodland, and pasture-cropland. Of these types, the most significant to wildlife resources within the region is the bottom land hardwood/riparian due to diversity of plant and animal species and general scarcity. Two large tracts of bottom land hardwoods have been tentatively identified within the study area by FWS (Brabander and Masters 1984) as part of a survey of remaining significant tracts in Oklahoma. One of these is along the North Canadian River in Okfuskee County in the vicinity of the Hickory Ridge damsite. The other tract is along the Deep Fork River, also in Okfuskee County. Damsites possibly affecting the latter tract include Tuskegee, Welty, and Nuyaka. All of the potential multipurpose reservoirs would affect smaller tracts of bottom land hardwoods or riparian/wetland ecosystems of local importance to wildlife.

New impoundments within the region would provide additional surface water fishery acreage for adaptable native species and for introduced game species. The SCORP shows a need for additonal surface water fishing acreage wihin the COEDD region. The development of either a Federal or State multipurpose reservoir would also provide public land and access to lake and stream areas (i.e., tail water, downstream or upstream corridors). Public lands adjacent to a new reservoir could be utilized for park facilities or game management/public hunting purposes to meet needs identified in the SCORP. The extent to which fishing and hunting needs would be met by an individual project and to which associated benefits would accrue is dependent on the lands and supporting facilities which may be incorporated in a multipurpose plan; agreements with local sponsors, the ODWC and OTRD; and the quality (from a recreational/fish and wildlife perspective) of the resources which can be placed in public ownership. Early and continuing coordination with all Federal, State, or local agencies having an interest in multipurpose water resource planning by either law or expertise can result in optimum benefits being realized for a given reservoir site.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Cleveland Res.
KEYSTONE LAKE
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Lake Carl Blackwell
Cushing Res.
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Chandler Lake
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Arcadia Lake
Sparks Lake
SCS Site 4M
Meeker Lake
Okemah Lake
Lake Henryetta
Weleetka Lake
Lake Wetumka
Dustin Lake
Stanley Draper Lake
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OKLAHOMA CITY AQUADUCT
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OKLAHOMA
STUDY AREA
LOCATION MAP
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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EAST-CENTRAL OKLAHOMA WATER SUPPLY STUDY

STUDY AREA MAP

Amarillo, Texas
January, 1985
Map No. 1484-500-25

CHAPTER VI - MINERAL RESOURCES

A. Introduction

Most of the material for this chapter has been abstracted from chapter 5 of Resource Assessment and Development Strategies, RedArk, October 1982. The project area has significant mineral resources. Most important of the minerals currently being extracted are petroleum and natural gas. Significant tonnages of nonmetallic industrial minerals are also being mined. Methane gas contained in coal beds and fly ash from coal-fired powerplants offer possible potential for future development. Metallic minerals occur in various locations, but their commercial potential has not been adequately investigated.

Mineral production plays a significant role in the economy of the study area. In 1975 approximately $209,976,000 worth of minerals was extracted. This amount was approximately 9.3 percent of the entire State's production, and it equates with the study area having 9.2 percent of the State's land area.

The economic benefits from mineral production are not uniformly distributed within the study area as shown in table VI-1. All of the westerly counties, especially in the southwest, show the greatest production value, while the three most easterly counties tend to produce very little.

Table VI-1
Value of Study Area Mineral Production by County, 1975 1/
(East-Central Oklahoma Water Supply Study, January 1985)

County	Value ($1,000)	Minerals Produced in Order of Value
Coal	4,948	Petroleum, natural gas, and stone
Hughes	9,383	Petroleum, natural gas, and sand and gravel
Lincoln	19,142	Petroleum, natural gas, and natural gas liquids
Okfuskee	8,649	Petroleum, natural gas, and natural gas liquids
Pawnee	10,314	Petroleum, stone, natural gas, and sand and gravel
Payne	20,532	Petroleum, stone, natural gas, and sand and gravel
Pontotoc	62,786	Petroleum, cement, stone, sand and gravel, natural gas, clays, and natural gas liquids
Pottawatomie	22,333	Petroleum, sand and gravel, and natural gas
Seminole	51,889	Petroleum, natural gas liquids, stone, natural gas, sand and gravel, and clays
Study Area Total	209,976	
State Total	2,267,095	

1/ Source: Dikeman, Earley, and others (1980), Table 10.01, as published in Resource Assessment and Development Strategies, RedArk, October 1982.

B. Petroleum and Natural Gas

The actual amounts of petroleum and natural gas in the region are not known. Resources, defined as amounts present, are probably huge. Reserves, the amounts which can actually be recovered economically, are certainly much smaller. The recent historical ratio between State-proved reserves of petroleum and production is about 8:1 (but slowly declining) and the ratio for natural gas is about 6:1 (also declining until 1980), thus it is likely that sufficient petroleum and natural gas reserves exist in the study area for at least 10 and perhaps 20 years at present or slowly declining rates of production.

In addition to the standard deposits of petroleum and gas, the study area also contains resources of natural asphalt deposits in Pontotoc County. Asphalt was mined until about 1960, but today's asphalt is supplied more economically from petroleum refining. It is likely that this resource will be mined in the future when dwindling petroleum reserves again make it cost competitive.

Natural gas production is a major contributor to the study area economy as symbolized by this compressor plant.

This petroleum storage complex north of Cushing, Oklahoma, illustrates petroleum production of the region.

Oklahoma has long been one of the major petroleum and natural gas producing states in the Nation. In 1979 it was fifth in petroleum and third in natural gas. The study area contributes unevenly to the State's production. Locations of study area oil and gas fields are shown on map No. 1484-500-13. In 1981 the area produced 21,552,394 barrels (bbl) of petroleum, representing about 14.2 percent of the State's total. Natural gas production was 56,978,975 thousands of cubic feet (M#ft^3) or about 2.8 percent of the State's total. Table VI-2 shows that study area production increased in 1981 over 1980 by 13 percent for petroleum and by nearly 19 percent with natural gas. Analysis of table VI-2 reveals that Pontotoc, Seminole, and Pottawatomie Counties are the leading petroleum producers; Coal, Okfuskee, and Hughes Counties produce the smallest amounts. Natural gas production is somewhat the reverse. Hughes and Lincoln Counties are the leaders, Coal dropped significantly, and Pawnee showed an astronomical 517 percent surge in production.

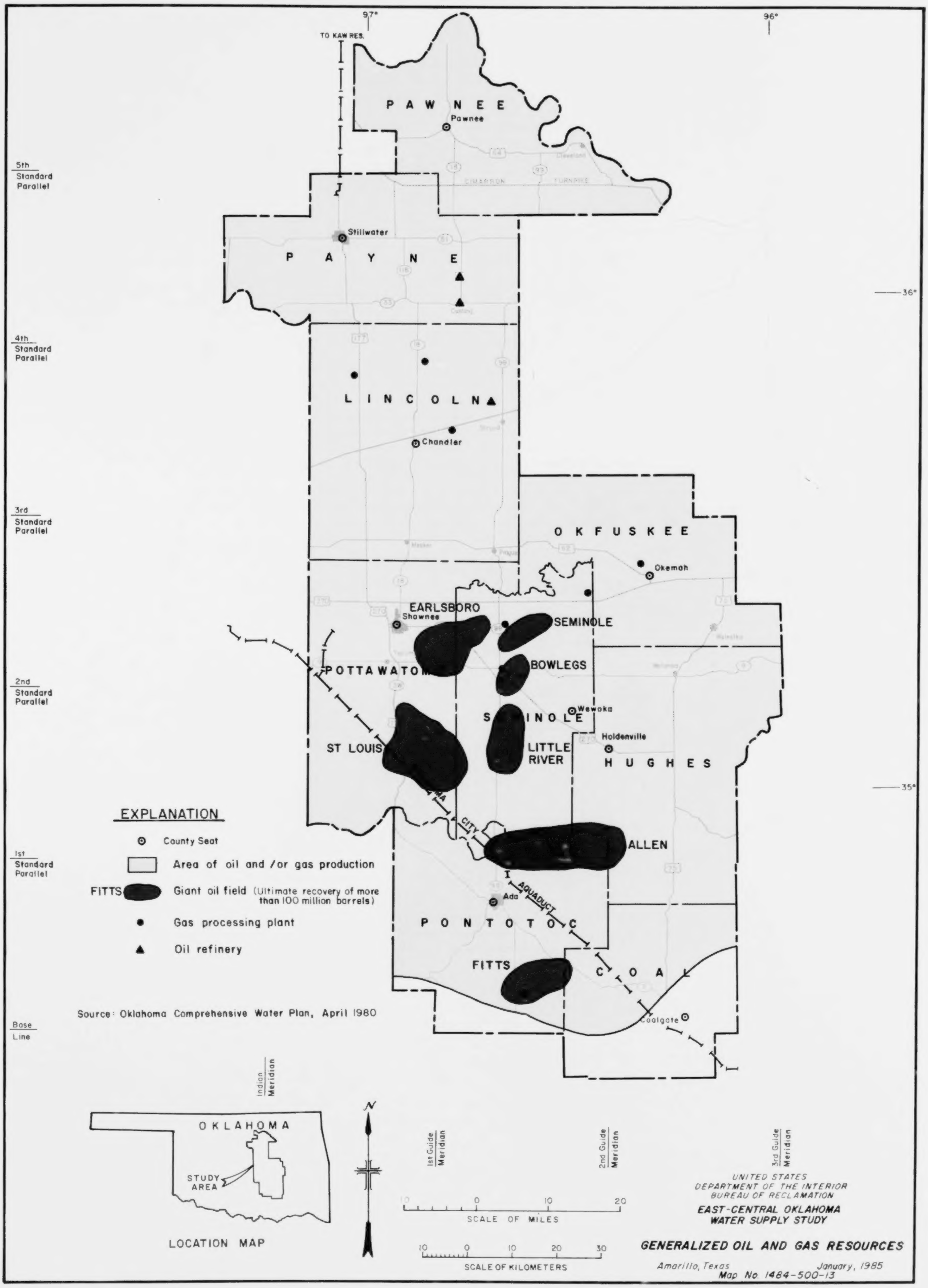
Table VI-2

Production of Petroleum and Natural Gas by County, 1980 and 1981 [1/]

(East-Central Oklahoma Water Supply Study, January 1985)

Year	County	Petroleum (bbl)	Natural Gas (M#ft^3)
1981	Coal	241,094	8,608,013
1980	Coal	215,012	12,991,439
1981	Hughes	1,078,218	12,490,839
1980	Hughes	779,483	11,184,470
1981	Lincoln	1,914,491	10,269,985
1980	Lincoln	2,041,299	7,618,013
1981	Okfuskee	982,729	6,114,667
1980	Okfuskee	795,358	5,641,393
1981	Pawnee	1,336,670	8,084,228
1980	Pawnee	1,067,454	1,310,829
1981	Payne	2,536,136	4,903,288
1980	Payne	1,993,951	4,117,176
1981	Pontotoc	5,560,819	1,387,560
1980	Pontotoc	5,554,874	1,246,740
1981	Pottawatomie	3,500,248	2,501,976
1980	Pottawatomie	2,353,406	1,449,510
1981	Seminole	4,371,989	2,618,419
1980	Seminole	4,222,978	2,436,806
1981	REGION TOTAL	21,522,394	56,978,975
1980	REGION TOTAL	19,023,815	47,996,376

[1/] Source: Rick Conner, Oklahoma Corporation Commission, as published in Resource Assessment and Development Strategies, RedArk, October 1982.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OKLAHOMA CITY AQUADUCT
ALLEN
1st Standard Parallel
Ada
PONTOTOC
FITTS
COAL
Coalgate
Base Line
EXPLANATION
County Seat
Area of oil and /or gas production
FITTS
Giant oil field (Ultimate recovery of more than 100 million barrels)
Gas processing plant
Oil refinery
Indian Meridian
OKLAHOMA
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LOCATION MAP
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Source: Oklahoma Comprehensive Water Plan, April 1980

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

GENERALIZED OIL AND GAS RESOURCES

Amarillo, Texas January, 1985
Map No. 1484-500-13

C. Coal

Coal has been mined commercially in Oklahoma since 1872. Until 1915, all coal mining in the State was underground. By the 1940's, strip mining accounted for half of the production, and in 1980 no deep mines were active.

In 1920 production in the State reached 4.85 million tons, an amount not exceeded until 1977. After 1930, coal production dropped sharply--first because of the depression and then because of replacement by natural gas for space heating and by diesel fuel for locomotives. Until 1970, coal production remained between 1.5 and 3.5 million tons per year, but production has risen steadily since then as more coal has been used by utilities. In 1980, mining totaled approximately 5.5 million tons, which makes Oklahoma the 20th-largest coal-producing State in the Nation. Although Coal and eastern Okfuskee contain significant amounts of coal (see map No. 1484-500-17 in section D, "Nonmetallic Industrial Minerals"), there are no production figures to indicate that either contributed to the 1980 State totals.

The coalbeds in the study area are known as the Arkoma Basin, which is in the southern part of the western region of the Interior Coal Province of the United States. There are at least eight major coalbeds in the general region. They range in thickness from 1 to 7 feet and are generally folded and frequently faulted. Dips in the beds range from 3 degrees to nearly vertical, and depths range from surface outcrops to over 3,000 feet. Due to this complex geometry, only about 3 percent of the region's resources are strippable.

Not all of the coal resources can be mined. About 50 percent of the coal in deep mines must be left as roof supports and is lost in preparation, and about 20 percent is not recoverable even in strip mining. Only about 50 percent of the coal in deep mines and 80 percent of the coal in strip mines can actually be produced (in amounts known as recoverable reserves). Also, thin coal seams at great depth or badly faulted coal seams are uneconomical to mine. Federal safety regulations prohibit mining of coal under towns and a certain border around deep mines. Environmental regulations prohibit mining in fragile areas. Coal underlying land with multiple owners usually cannot be mined. The study area's net recoverable reserves, the amount of coal likely to be mineable in the near future after all of these factors are taken into account, total only 36.4 percent of the resource or 135,552,000 short tons as shown in table VI-3. This percentage is more favorable than the State's 28.8 percent. However, it should be noted that coal production will play a very limited role in the study area's economic development due to the fact that the study area contains only 6.1 percent of the State's net recoverable reserves, most of which are located in Coal County.

Table VI-3
Summary of Remaining Bituminous Coal Resources and Net Recoverable Reserves by County as of January 1, 1979 1/
(East-Central Oklahoma Water Supply Study, January 1985)

County	Resources	Recoverable Reserves (Thousands of Short Tons)	Net Recoverable Reserves
Coal	292,875	148,017	115,929
Okfuskee	79,351	41,390	19,623
Study Area Total	372,226	189,407	135,552
State Total	7,773,613	3,779,487	2,238,777

1/ Source: Friedman 1974, Tables 2, 59-72; Friedman and Hemish 1981, as published in Resource Assessment and Development Strategies, RedArk, October 1982.

All of the coal in the study area is bituminous. It tends to be low and medium volatile and fairly low in sulfur, and it has a high Btu (British thermal unit) content. Though all of the coal can be burned by utilities and industries with proper equipment, the majority or about 66 percent of the net recoverable resources is best suited for coke manufacture.

The nature of the region's coal and its location are barriers to its further development as a resource and as a replacement supply of energy for the study area as petroleum supplies dwindle and become more costly. It cannot be easily strip mined, and deep mines are 60 percent more costly than strip mines. Deep mining is particularly difficult because of high levels of methane gas, which is difficult to vent adequately to avoid explosions. Much of the coal is best suited as coking coal which is more expensive than normal steam coal; its demand has declined with the heavy industry that uses it. Lastly, these coal supplies are poorly located to be price competitive to supplies located near large demand centers.

D. Nonmetallic Industrial Minerals

The study area has large amounts of nonmetallic industrial minerals as shown in map No. 1484-500-17. They include limestone, dolomite, sandstone, sand and gravel, clay and shale, and fly ash.

The major limestone formation is associated with the Arbuckle Mountains, with significant amounts found in Pontotoc County. Smaller deposits occur in thinner beds in Seminole, Payne, and Pawnee Counties. The limestone is primarily suitable for crushing for cement, highway and concrete aggregate, and railroad ballast; but some can be quarried in large blocks and will take a high polish, making it desirable as dimension stone in building.

As illustrated, limestone mining is an important industry in portions of the study area.

Cement production is a major use of limestone as illustrasted by this plant in Ada.

Dolomite, which is a carbonate rock-like limestone but contains magnesium as well as calcium, is found in the Arbuckle Mountain area including Pontotoc County. Due to its high purity, dolomite is used for fluxing stone, glass manufacture, refractories, and magnesium metal. Other common uses include feed, soil conditioner, dolomitic lime for fertilizers, and dimension stone.

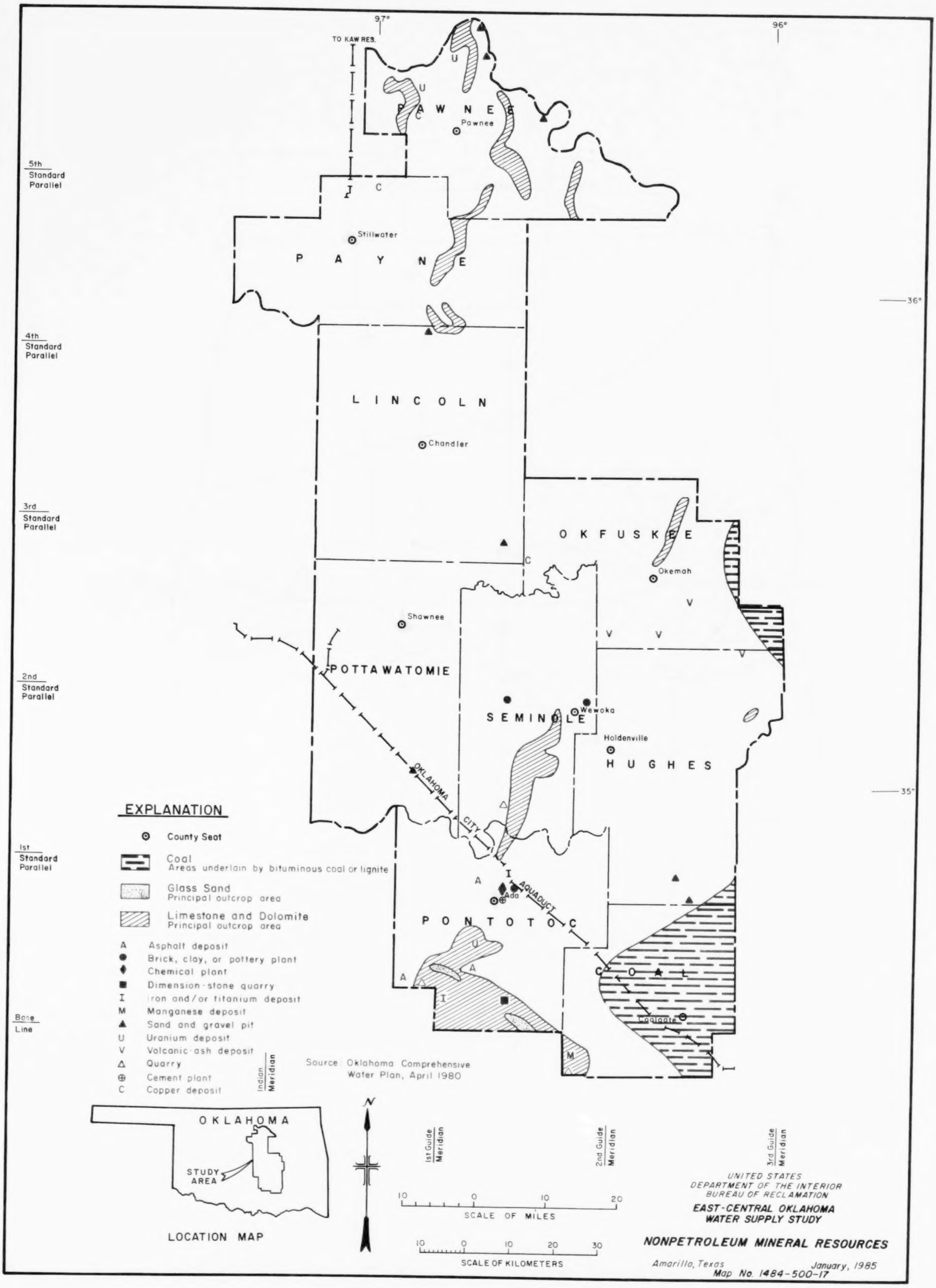
Sandstone, a common rock type, occurs in all parts of the study area. In the study area, it is quarried as a concrete and highway aggregate.

Sand and gravel, like sandstone, are extremely common throughout the study area, primarily in terraces along streams and rivers. They are used in making concrete and as railroad ballast. In addition, extensive deposits of very fine-grained high-silica sand, which actually is a loosely consolidated rock formation, are found in the Arbuckle Mountain area including Pontotoc County. These deposits are mined for glass manufacture.

Clay and shale are used for manufacturing brick and tile. An additonal clay resource which has received some study is underclay found below coal seams. Small amounts are used for making fire bricks and refactory material. They appear suitable for making high-quality pottery and ceramics.

Fly ash is the very fine-grained waste material entrained in combustion gases when coal is burned. Very little of it is produced by burning Oklahoma bituminous coal which fuses and forms a coarse bottom ash, but large amounts are formed when subbituminous Wyoming coal is burned in the Oklahoma powerplants. Normally this ash, except for the smallest size particles which are trapped by electrostatic precipitators and baghouses, is simply placed in landfills. Recently, however, concern about the large amount of land required for disposal has generated interest among utilities to use it in fill, soil stabilizers, and cement. Tests show that it can be substituted for proportions up to 30 percent. However, questions have been raised about such cement being corrosive to metal reinforcing bars embedded in such concrete. Fly ash also has potential for recovery of metallic resources, which will be discussed under the next heading.

Nonmetallic industrial minerals have been developed to a considerable degree in some of the study area counties such as Pontotoc, Seminole, Pawnee, and Payne as shown in table VI-4. However, Lincoln and Okfuskee Counties do not produce these minerals; Hughes County produces an insignificant amount. This limited production results in the study area producing only 8.0 percent of the State total.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Stillwater
4th Standard Parallel
36°
L I N C O L N
Chandler
3rd Standard Parallel
O K F U S K E E
Okemah
Shawnee
POTTAWATOMIE
2nd Standard Parallel
S E M I N O L E
Wewoka
Holdenville
H U G H E S
OKLAHOMA CITY AQUADUCT
35°
1st Standard Parallel
Ada
P O N T O T O C
C O A L
Coalgate
Base Line
Indian Meridian
1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
N
OKLAHOMA
STUDY AREA
LOCATION MAP
10 0 10 20
SCALE OF MILES
10 0 10 20 30
SCALE OF KILOMETERS

EXPLANATION

⊙ County Seat

Coal
Areas underlain by bituminous coal or lignite

Glass Sand
Principal outcrop area

Limestone and Dolomite
Principal outcrop area

A	Asphalt deposit
●	Brick, clay, or pottery plant
♦	Chemical plant
■	Dimension-stone quarry
I	Iron and/or titanium deposit
M	Manganese deposit
▲	Sand and gravel pit
U	Uranium deposit
V	Volcanic-ash deposit
△	Quarry
⊕	Cement plant
C	Copper deposit

Source: Oklahoma Comprehensive Water Plan, April 1980

UNITED STATES
DEPARTMENT OF THE INTERIOR
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EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

NONPETROLEUM MINERAL RESOURCES

Amarillo, Texas *January, 1985*
Map No. 1484-500-17

Table VI-4
Tonnage of Nonmetallic Industrial Mineral Production by County, 1980 [1]
(East-Central Oklahoma Water Supply Study, January 1985)

County	Limestone/ Dolomite/ Sandstone	Granite	Sand/ Gravel	Clay/ Shale	Total
Coal	47,994	-	-	-	47,994
Hughes	-	-	2,875	-	2,875
Lincoln	-	-	-	-	0
Okfuskee	-	-	-	-	0
Pawnee	318,379	-	-	-	318,379
Payne	179,659	-	115,690	-	295,349
Pontotoc	1,604,131	-	372,455	6,326	1,982,912
Pottawatomie	-	-	97,559	-	97,559
Seminole	673,473	-	155,000	-	828,473
Region Total	2,823,636	-0-	743,579	6,326	3,573,541
State Total	27,820,468	6,999	9,450,006	597,341	44,760,836

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[1] Source: Qualls 1981, as published in Resource Assessment and Development Strategies, RedArk, October 1982.

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E. Metallic Resources

The study area has no presently mined metals or known commercially mineable ore deposits under current economic conditions. There are, however, a number of occurrences of metals as seen in map No. 1484-500-17. Mining has occurred in the past.

In Pawnee, Payne, Lincoln, Okfuskee, and Pottawatomie Counties, there are occurrences, old prospects, and mined-out small deposits of copper; there are also some uranium occurrences in sandstones of Permian age (see map No. 1484-500-16 in chapter IX).

Coal County has manganese deposits. The Arbuckle Mountain region has a number of metal deposits; iron and uranium are found in Pontotoc County. The iron has been mined for use in special cements.

One final metallic resource is fly ash. This material contains significant amounts of aluminum and iron as well as smaller amounts of strategic metals such as chromium, cobalt, and manganese.

F. Problems and Needs

Current forecasts indicate that the study area's presently known oil and gas reserves will become depleted within the next 10 to 20 years. Deep wells, isolated deposits, and additional secondary and tertiary recovery from old fields, heretofore too costly to undertake, will become cost feasible when depleting world supplies result in rising prices. These same high prices will also constrain output to a fraction of present production, which will be a disastrous blow to the study area's and State's economic vitality. A great deal of effort will be required to generate enough economic development to replace the earnings and tax base that will be lost to the study area.

Neither study area county having coal deposits is presently producing any commercial tonnage. Given constraints of type of coal and location, the downturn in domestic steel production, and cost factors associated with antipollution equipment needed to burn this coal, there appears to be little economic incentive to reinstitute active coal mining in the two study area counties. Unless future technology provides less costly emission controls for power-generating plants or escalating energy prices make methane gas recovery or synthetic fuel production commercially feasible, there appears to be little hope for substantive development of coal production in the study area.

With dwindling available supplies of petroleum and natural gas at much higher prices and serious questions about the region's coal being able to replace it at an economical price, the study area needs to concern itself with how it will replace its own energy needs at an affordable price. The one largely untapped energy resource in the study area (other than solar energy), which is in ample supply, is moving water which has the additional advantage of being a constantly renewable resource. A serious, comprehensive effort needs to be undertaken immediately to determine how hydroelectric power might be used to supply the study area with low-cost electric power as a replacement for fossil fuel energy.

CHAPTER VII - LAND, AGRICULTURAL, AND FORESTRY RESOURCES

A. Land Characteristics

The study area has 4,075,582 acres of land area, which represents 9.3 percent of the State total.

Soils in the study area developed under relatively humid conditions where leaching is intense. Generally, these soils are low in phosphorus, lack adequate potassium, and range from moderately to strongly acid.

Soil associations occur together naturally in a defined proportional pattern on an unique type of landscape. These associations are comprised of several series whose characteristics, including climate, parent materials, and natural vegetation, are similar. The study area contains six major land resource areas based on the major soil associations. These areas are graphically displayed on map No. 1484-500-10, and the associated soils are briefly described in the following tabulation:

Land Resource Areas [1/]

1. Cross Timbers - Light-colored sandy soils with reddish subsoils on various sandy materials developed under oak-hickory forests with prairie openings (savannah).

2. Reddish Prairie - Dark soils with clayey subsoils developed under tall grass mostly in clayey Red Beds.

3. Grand Prairie - Dark loamy and clayey soils with clay subsoils developed in marine clay and limestones under tall grasses.

4. Cherokee Prairies - Dark-colored soils mostly with clayey subsoils developed on shales, sandstones, and limestones under tall grasses.

5. Ouachita Highlands - Light-colored acid sandy to loamy soils with heavier subsoils and shallow soils developed on sandstones and shales under oak-hickory-pine forests.

6. Bottom lands - Nearly level, deep sandy to clayey bottom land soils. Some areas flood frequently, most flood occasionally, and some rarely. Soils are developed under lowland hardwoods which decrease in density from east to west.

[1/] Source: Soil Map of Oklahoma, published by the Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma. Based on surveys by the Soil Survey Staff of the Soil Conservation Service, U.S. Department of Agriculture, and the Agronomy Department, Oklahoma State University.

Approximately 66.8 percent of the study area is classified as arable (tillable). Of the 33.2 percent nonarable (nontillable) acres in the study area, Seminole County has the most with 228,533 nonarable acres, which is over half its total (56.5 percent). Percent of nonarable acres for the remaining study area counties in descending order are: Pontotoc - 43.8 percent, Hughes - 36.9 percent, Lincoln - 34.6 percent, Pawnee - 33.2 percent, Pottawatomie - 31.2 percent, Coal - 26.0 percent, Payne - 20.7 percent, and Okfuskee - 13.0 percent. Table VII-1 displays the data for arable and nonarable land in the study area by major soil groupings.

B. Agricultural Characteristics

Table VII-2 displays data concerning the number and size of farms in the study area. Analysis of this data reveals that the study area has a predominance of small farms. Half of the farms in the area account for only 12.5 percent of the land in farms, while only 14.4 percent of the large study area farms account for 57.0 percent of farmland. Largest in percentage of land in farms is Coal County with 84.3 percent, while Seminole County has the smallest percentage of 63.7. The study area average is 70.8 percent. Lincoln County has the largest number of farms with 1,731; Coal County records the smallest number with 589. Total number of farms for the study area is 9,224. Coal County again leads with the largest average size farms with 477 acres, while the study area average is 310 acres and Pottawatomie County has the smallest average with 232 acres. Table VII-3 provides data on how study area farmland is used. Analysis of this table (1982 use) and the total land in farms from table VII-2 make it clear that cropland is not abundant in the study area, ranging from about one-fifth to slightly over one-third of total land in farms. In addition, a majority of study area farmers elect to use more than 50 percent of their limited cropland for pasture only. The net result is that approximately 74 to 87 percent of the total farmland in study area counties is used as pastureland as shown the following tabulation:

Selected Analyses of Land Use on Study Area Farms in 1982
(East-Central Oklahoma Water Supply Study, January 1985)

Total Cropland as a Percentage of Land in Farms

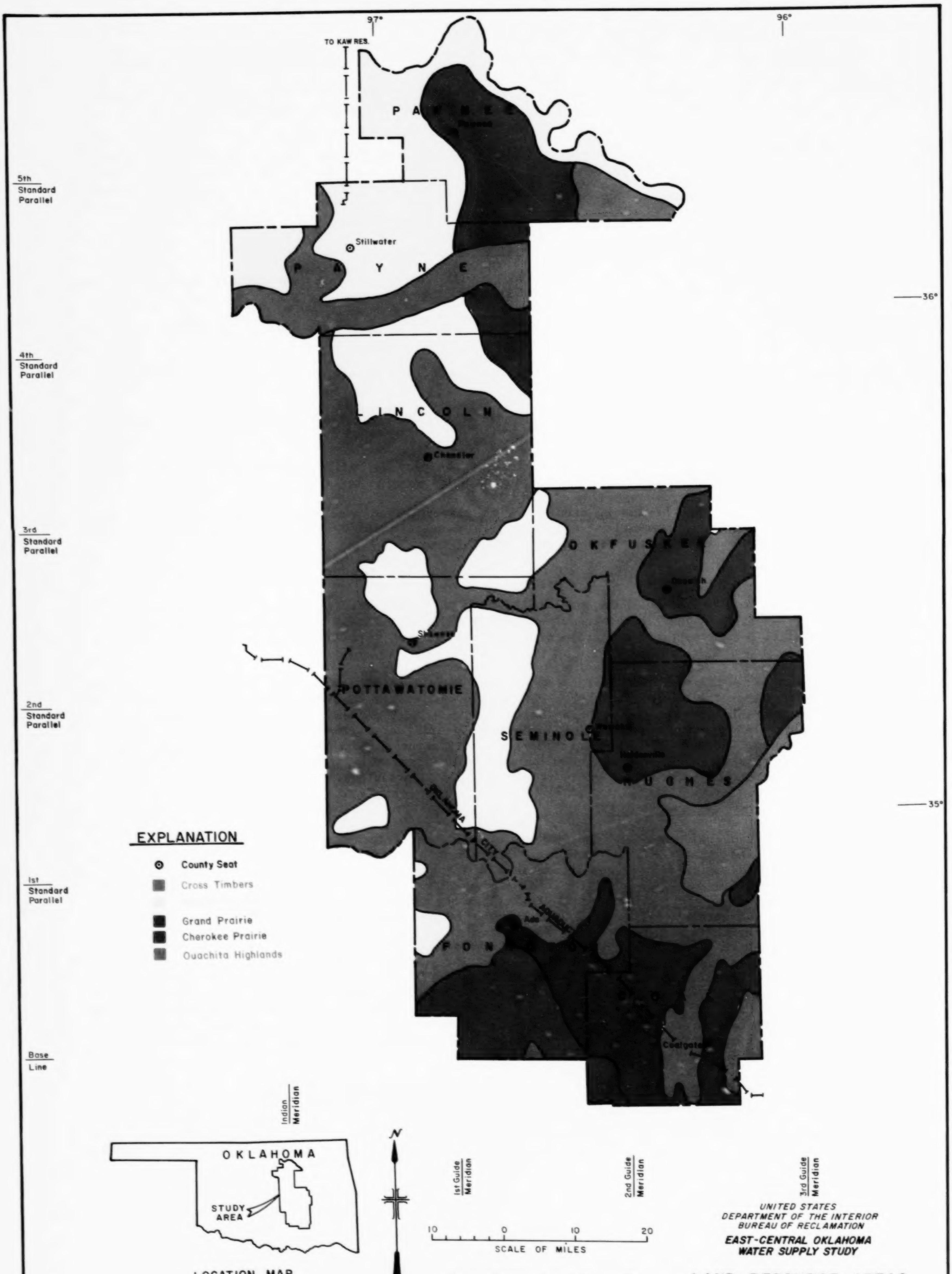
Pottawatomie - 38.2
Payne - 35.8
Seminole - 34.7
Lincoln - 33.0
Okfuskee - 30.8
Hughes - 28.8
Pawnee - 26.1
Pontotoc - 26.0
Coal - 22.4

Cropland Used for Pasture only as a Percentage of Total Cropland

Seminole - 61.0
Pontotoc - 60.6
Lincoln - 55.6
Coal - 54.5
Okfuskee - 53.7
Hughes - 52.5
Pottawatomie - 51.3
Payne - 40.1
Pawnee - 33.1

Pastureland - All Types as a Percentage of Land in Farms

Coal - 86.9
Pontotoc - 85.3
Okfuskee - 80.8
Seminole - 79.5
Pawnee - 79.4
Lincoln - 78.7
Hughes - 78.0
Pottawatomie - 76.4
Payne - 73.5


97°
96°
TO KAW RES.
PAWNEE
Pawnee
5th Standard Parallel
PAYNE
Stillwater
36°
4th Standard Parallel
LINCOLN
Chandler
3rd Standard Parallel
OKFUSKEE
Okemah
SHAWNEE
POTTAWATOMIE
2nd Standard Parallel
SEMINOLE
Wewoka
Holdenville
HUGHES
OKLAHOMA CITY AQUEDUCT
35°
1st Standard Parallel
PONTOTOC
Ada
COAL
Coalgate
Base Line
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EXPLANATION
County Seat
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Grand Prairie
Cherokee Prairie
Ouachita Highlands
OKLAHOMA
STUDY AREA
LOCATION MAP
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1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
10 0 10 20
SCALE OF MILES
10 0 10 20 30
SCALE OF KILOMETERS

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EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

LAND RESOURCE AREAS

Amarillo, Texas *January, 1985*
Map No. 1484-500-10

Table VII-1
Acres for All Study Area Counties: Arable and Nonarable Land, 1/
By Major Soil Groupings 2/
(East-Central Oklahoma Water Supply Study, January 1985)

	Ouachita Highlands		Grand Prairie		Flood Plains 3/	Cross Timbers		Cherokee Prairie		Reddish Prairie		Terrace & Footslopes 3/	Total Acres
	Arable	Nonarable	Arable	Nonarable	Arable	Arable	Nonarable	Arable	Nonarable	Arable	Nonarable	Arable	
Coal	--	--	16,832	6,732	43,763	70,691	74,064	117,824	6,732	--	--	--	336,638
Hughes	43,545	174,183	--	--	41,472	--	--	153,965	17,107	--	--	88,128	518,400
Lincoln	--	--	--	--	103,884	82,944	154,040	--	--	182,984	61,211	37,657	622,720
Okfuskee	--	--	--	--	27,820	119,232	31,795	158,976	19,872	501	--	39,243	397,439
Pawnee	--	--	--	--	52,982	6,545	53,944	91,699	44,467	63,543	27,234	37,824	378,233
Payne	--	--	--	--	47,360	26,571	12,725	35,986	--	169,146	79,000	73,401	444,189
Pontotoc	--	--	56,610	90,630	69,060	35,970	101,490	60,000	9,000	--	--	36,800	459,560
Pottawatomie	--	--	--	--	82,227	36,720	112,316	--	--	173,175	47,810	61,670	513,918
Seminole	--	--	--	--	60,672	27,504	178,602	14,157	6,067	29,122	43,864	44,492	404,480
Total	43,545	174,183	73,442	97,362	529,240	406,177	718,976	632,607	103,245	618,471	259,119	419,215	4,075,582 4/

1/ Terms arable and nonarable are used in this table in the traditional sense of tillable and nontillable. Terms are not used as specialized Reclamation terminology having to do with potential irrigability.
2/ Source: Oklahoma Soil Surveys and Dr. Jim Stiegler, Department of Agronomy, Oklahoma State University.
3/ Headings of "Flood Plains" and "Terraces & Footslopes" are physiographic rather than soil groups. Acres listed under these headings lie along all study area streams and include lands from all of the major soil groupings.
4/ This total includes 2,722,697 arable acres and 1,352,885 nonarable acres of land.

Table VII-2
Number of Farms by Size, 1982 1/
(East-Central Oklahoma Water Supply Study, January 1985)

	Coal County		Hughes County		Lincoln County		Okfuskee County		Pawnee County	
	No. Farms	Acres	No. Farms	Acres	No. Farms	Acres	No. Farms	Acres	No. Farms	Acres
Total farms	589		908		1,731		745		643	
Land in farms		280,677		338,367		404,393		268,687		280,641
Average size of farm		477		373		234		361		436
Approximate land area		333,081		515,552		617,081		402,003		352,947
Proportion in farms (percent)		84.3		65.6		65.5		66.8		79.5
Land in farms (by size)										
1 to 9 acres	13	48	20	56	48	162	16	41	22	76
10 to 49 acres	61	1,877	91	3,081	217	6,260	87	2,677	66	1,974
50 to 69 acres	25	1,451	22	1,264	88	5,176	22	1,293	21	1,232
70 to 99 acres	48	3,862	115	9,386	280	22,536	101	8,051	50	4,046
100 to 139 acres	56	6,449	86	10,051	123	14,412	67	7,816	30	3,494
140 to 179 acres	61	9,506	129	20,261	305	48,475	89	14,112	92	14,487
180 to 219 acres	26	5,190	44	8,507	89	17,583	54	10,548	31	6,134
220 to 259 acres	49	11,589	65	15,456	103	24,471	47	11,187	43	10,105
260 to 499 acres	118	41,824	173	61,361	298	105,300	122	44,509	140	50,814
500 to 999 acres	73	49,736	102	68,425	135	92,636	81	58,906	93	66,426
1,000 to 1,999 acres	36	45,686	44	61,457	37	45,534	45	58,644	33	45,485
2,000 acres or more	23	103,459	17	79,062	8	21,848	14	50,903	22	76,368

1/ Source: 1982 Census of Agriculture, tables 1 and 4.

Table VII-2 (Continued)
Number of Farms by Size, 1982 1/
(East-Central Oklahoma Water Supply Study, January 1985)

	Payne County		Pontotoc County		Pottawatomie County		Seminole County		Study Area	
	No. Farms	Acres	No. Farms	Acres	No. Farms	Acres	No. Farms	Acres	No. Farms	Acres
Total farms	1,123		1,048		1,407		1,030		9,224	
Land in farms		305,027		394,487		326,704		256,094		2,855,077
Average size of farm		272		376		232		249		310
Approximate land area		441,990		458,841		501,318		408,646		4,031,459
Proportion in farms (percent)		69.0		86.0		65.2		62.7		70.8
Land in farms (by size)										
1 to 9 acres	60	218	32	86	62	259	34	105	307	1,051
10 to 49 acres	167	4,433	187	5,324	248	6,990	199	6,636	1,323	39,252
50 to 69 acres	53	3,072	58	3,301	75	4,220	52	3,099	416	24,108
70 to 99 acres	153	12,381	99	8,014	219	17,684	123	9,942	1,188	95,902
100 to 139 acres	76	9,142	134	15,511	137	16,326	129	15,210	838	98,411
140 to 179 acres	171	27,019	97	15,123	172	27,171	113	17,596	1,229	193,750
180 to 219 acres	47	9,215	64	12,637	76	14,937	81	15,895	512	100,646
220 to 259 acres	60	14,211	62	14,652	65	15,461	47	11,145	541	128,277
260 to 499 acres	170	61,434	163	56,587	195	68,629	166	57,108	1,545	547,566
500 to 999 acres	123	84,989	94	64,439	108	76,278	53	34,936	862	596,771
1,000 to 1,999 acres	35	48,042	32	43,422	43	57,335	19	23,401	324	429,006
2,000 acres or more	8	30,871	26	155,391	7	21,414	14	61,021	139	600,337

1/ Source: 1982 Census of Agriculture, tables 1 and 4.

Table VII-3
Land in Farms, According to Use 1/
(East-Central Oklahoma Water Supply Study, January 1985)

	Coal County				Hughes County				Lincoln County				Okfuskee County				Pawnee County			
	Farms		Acres		Farms		Acres		Farms		Acres		Farms		Acres		Farms		Acres	
	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)
Land in farms according to use																				
Total cropland	424	415	63,720	62,980	717	711	96,989	97,609	1,226	1,258	140,065	133,507	604	570	87,032	82,720	505	488	81,640	73,291
Harvested cropland	337	321	23,622	22,962	551	504	37,585	37,155	926	918	52,998	50,359	448	400	32,673	32,203	431	380	47,250	44,936
By acres harvested																				
1 to 9	31	18	175	2/	53	41	221	233	92	108	424	511	54	40	213	212	26	34	118	166
10 to 19	54	35	711	442	92	99	1,219	1,299	166	168	2,232	2,217	68	63	867	806	55	43	735	574
20 to 29	48	59	1,080	1,323	76	73	1,765	1,610	126	147	2,833	3,358	56	70	1,248	1,502	52	37	1,180	836
30 to 49	60	72	2,220	2,539	118	87	4,263	3,195	206	179	7,492	6,557	80	60	2,893	2,238	91	71	3,439	2,701
50 to 99	76	75	5,109	5,162	107	103	7,474	7,090	177	181	11,525	12,254	92	83	6,276	5,685	82	68	5,570	4,777
100 to 199	44	36	5,908	4,446	64	51	8,997	6,538	115	97	15,243	12,569	61	47	7,880	6,410	58	71	7,802	9,931
200 to 499	19	23	5,064	6,569	36	42	9,969	12,275	40	33	10,800	8,848	31	30	8,339	9,491	48	42	14,213	12,923
500 to 999	5	2	3,355	2/	5	8	3,677	4,915	4	4	2,449	2/	5	6	2/	2/	15	8	9,087	4,945
1,000 or more	--	1	--	2/	--	--	--	--	--	1	--	2/	1	1	2/	2/	4	6	5,106	8,083
Cropland used only for pasture	214	209	39,083	34,342	354	363	45,629	51,197	653	660	75,796	74,165	318	329	45,276	44,385	205	213	30,341	24,288
Other cropland	24	38	1,015	5,676	178	123	13,775	9,257	250	209	11,271	8,983	123	87	9,083	6,132	89	79	4,049	4,067
Total woodland	191	250	38,569	34,483	385	393	58,522	65,339	735	799	52,830	63,351	348	326	37,179	35,952	198	190	21,192	14,647
Woodland pastured	167	225	33,458	30,779	317	335	48,364	49,261	642	699	47,695	53,386	296	280	30,843	30,220	178	165	17,382	12,144
Woodland not pastured	36	45	5,111	3,704	96	105	10,158	16,078	147	192	5,135	10,965	92	70	6,336	5,732	41	42	3,810	2,503
Other land	412	443	179,417	183,214	679	640	196,441	175,419	1,280	1,377	213,820	207,535	536	549	105,623	86,974	552	523	214,635	192,703
Pastureland, all types	512	552	245,106	243,794	816	831	282,408	264,000	1,477	1,613	322,643	318,084	683	695	225,129	217,090	602	596	256,248	222,902

1/ Source: U.S. Census of Agriculture, 1978 and 1982.
2/ Withheld to avoid disclosing data for individual farms.

Table VII-3 (Continued)
Land in Farms, According to Use [1/]
(East-Central Oklahoma Water Supply Study, January 1985)

	Payne County				Pontotoc County				Pottawatomie County				Seminole County			
	Farms		Acres		Farms		Acres		Farms		Acres		Farms		Acres	
	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)	(1978)	(1982)
Land in farms according to use																
Total cropland	819	833	106,263	109,300	757	790	93,707	102,537	967	1,023	119,177	124,790	727	719	93,680	88,774
Harvested cropland	647	632	56,108	57,671	543	547	33,369	31,327	661	646	49,913	49,635	496	467	30,993	27,204
By acres harvested																
1 to 9	66	68	272	331	57	83	307	418	88	90	383	429	67	51	315	238
10 to 19	94	93	1,224	1,223	98	113	1,247	1,427	117	106	1,513	1,323	95	106	1,252	1,336
20 to 29	81	81	1,829	1,831	74	83	1,675	1,838	91	80	2,056	1,754	82	82	1,818	1,836
30 to 49	119	102	4,437	3,815	107	100	3,874	3,601	119	127	4,400	4,643	94	104	3,435	3,853
50 to 99	120	129	8,582	9,202	120	91	7,916	6,132	112	106	7,579	7,353	93	64	6,193	4,145
100 to 199	87	79	11,942	10,778	57	55	7,854	6,911	69	79	9,532	10,802	45	38	5,634	5,080
200 to 499	67	61	20,151	19,523	25	14	7,476	3,970	48	44	13,972	13,453	14	16	3,655	3,736
500 to 999	13	19	7,671	10,968	5	7	3,020	2/	17	12	10,478	2/	4	3	2/	1,900
1,000 or more	--	--	--	--	--	1	--	2/	--	2	--	2/	2	3	2/	5,080
Cropland used only for pasture	446	421	43,981	43,857	427	458	55,821	62,096	554	597	60,321	63,988	437	451	57,651	54,182
Other cropland	151	143	6,174	7,772	90	79	4,517	9,114	167	188	8,943	11,167	101	99	5,036	7,388
Total woodland	357	399	25,636	28,497	320	356	36,351	37,216	488	546	41,693	34,961	371	396	31,328	36,574
Woodland pastured	289	323	19,599	23,307	283	309	30,119	30,921	409	444	32,992	29,044	322	323	25,879	29,619
Woodland not pastured	102	105	6,037	5,190	57	75	6,232	6,295	121	153	8,701	5,917	74	101	5,449	6,955
Other land	879	931	184,190	167,230	728	729	233,288	254,734	918	1,067	161,450	166,953	664	712	138,901	130,746
Pastureland, all types	970	989	239,381	224,214	912	941	306,431	336,441	1,160	1,261	244,556	249,459	884	908	214,044	203,632

1/ Source: U.S. Census of Agriculture, 1978 and 1982.
2/ Withheld to avoid disclosing data for individual farms.

Table VII-4 presents data on type of farm by number and value of agricultural products sold in 1982. Average value of per farm sales shows very uneven distribution in the study area with Seminole County lowest at $10,275 per farm and Pawnee County highest at $28,681, which is 279 percent greater than average Seminole County sales. The average per farm income for the study area is $15,744, which is 45 percent of the $34,886 State average. Livestock poultry-type enterprises dominated in the study area, ranging from 97.3 to 67.5 percent of the total sales value, while crop sales ranged from 2.7 to 32.5 percent of total sales value. Details are presented in the tabulation below:

Analysis of Farms by Value of Agricultural Products Sold in 1982
(East-Central Oklahoma Water Supply Study, January 1985)

Average Per Farm (Dollars)			Type of Enterprise	
			Livestock, Poultry and their Products (Percentage of total value)	Crops (Percentage of total value)
Pawnee	28,681	Coal	97.3	2.7
Payne	21,012	Pontotoc	95.3	4.7
Pontotoc	19,204	Lincoln	88.9	11.1
Coal	17,799	Seminole	85.0	15.0
Study area	15,744	Study area	84.6	15.4
Pottawatomie	13,802	Pawnee	83.8	16.2
Okfuskee	13,786	Okfuskee	82.7	17.3
Hughes	13,718	Payne	81.0	19.0
Lincoln	12,376	Pottawatomie	78.9	21.1
Seminole	10,275	Hughes	67.5	32.5

Data and analyses of the socioeconomic characteristics of farm proprietors and operators are not presently available since Reclamation has just initiated its social assessment of the study area. However, since the study area counties comprise nearly 40 percent of the 24-county RedArk region, highlights of socioeconomic findings in the 1982 Resource Assessment and Development Strategies have relevance and are paraphrased here for general information.

Part-time farming is predominant in the region. Sixty-eight percent of farmers worked at jobs other than farming in 1978. Nearly 60 percent worked off the farm 100 days or more; about one-half worked off the farm 200 days or more. Only a third of all farm operators listed farming as their principal occupation. Over two-thirds of the farm operators lived on the farms they operated. The average age of all farm operators was 52 years; over two-thirds of these operators were over 45 years of age; and 20 percent were over 65 years of age. Sixty-three percent of the farm operators were full owners of their farms, 29 percent part owners, and 7 percent tenants. However, part owners operated 48 percent of the land in farms, full owners 45 percent, and tenants only 7 percent. Over 92 percent of all farms operated were individual or family organizations controlling over 86 percent of the farmland. Farm employment accounted for 14 percent of total employment in the region in 1979. Net farm proprietor's income for the region has consistently lagged behind that for the State; for example, in 1979, average net farm proprietors' income per proprietor for the region was 36 percent ($2,856) of the State average of $7,850.

C. Potential Irrigation Resources

1. Present use. Irrigation is relatively new in the study area. Although the area receives an ample amount of rainfall each year, it is unevenly distributed by seasons; and drought periods adversely affect crop yields and pasture performance. Supplemental irrigation is reported to be generally profitable. 1/ There are no Federal irrigation projects in the study area.

In 1981 Reported Water Use (OWRB 1984), 13,055 acres were reported as irrigated in the study area, which represents only 0.5 percent of the area's tillable acres. Surface water application predominated with 9,235 acres, which represents 70.7 percent of the total. Ground water applications exceeded surface water in Payne and Seminole Counties only. Hughes County led the study area with 4,024 acres irrigated followed by Pottawatomie with 3,254 acres, Pontotoc with 2,260 acres, Okfuskee with 1,487 acres, Payne with 770 acres, Seminole with 571 acres, Lincoln with 264 acres, and Pawnee with 235 acres; and Coal with 190 acres.

Peanuts, with 3,999 acres, was the leading irrigated crop in the study area for 1981, representing 30.6 percent of the acres irrigated. Second was pasture with 2,510 acres (19.2 percent), followed by alfalfa with 1,753 acres (13.4 percent), wheat with 1,334 acres (10.2 percent), and soybeans with 894 acres (6.8 percent). These 5 crops, out of the 13 reported, accounted for 80.2 percent of the irrigated acreage.

Irrigator preferences for energy source for pumps (number of units) were propane - 82, natural gas - 20, electricity - 18, diesel - 17, and gasoline - 11. Types of irrigation systems used were gravity - 13, trickle-drip - 4, center pivot sprinklers - 14, and other sprinklers - 111. Table VII-5 presents a detailed analysis of 1981 reported irrigation information.

1/ Resource Assessment and Development Strategies, RedArk, October 1982.

2. Future irrigation development potential. Professionals in the region have indicated there is a potential for many more acres of crops and pastures to be irrigated if additional research on more efficient application and utilization of water were provided to farmers in the area. 1/ To that end, RedArk has been advocating that State and Federal agencies involved with its comprehensive economic development planning (a) develop and demonstrate state-of-the-art irrigation management methods, especially supplemental irrigation; (b) investigate development of specialty crop enterprises; and (c) investigate potential for project-type irrigation.

A proposal by Dr. James Nelson, OSU, for evaluating the economic potential of water development for specialty crop (fruits and vegetables) irrigation in the RedArk region is presently under consideration. Objectives of the proposed research effort are (a) identify and evaluate the potential of land resources for vegetable production as well as the availability and costs of surface and groundwater supplies and (b) estimate the economic impacts which would accrue to local economies in southeastern Oklahoma with the development of a fresh vegetable production and processing industry.

Based on existing Reclamation and SCS data, potentially irrigable lands have been inventoried in the study area. These lands are scattered throughout the study area, but the better quality lands are adjacent to the major streams as shown on map No. 1484-500-12. Potentially irrigable land includes those lands that appear to be capable of sustained irrigation production, assuming there are no limiting factors such as soils, topography, drainage, and availability of an adequate supply of acceptable quality water. Before specific delineations of irrigable lands can be determined, more detailed analysis will be necessary.

It is not probable that all lands identified in this report are suitable for sustained irrigation. There are areas with favorable conditions that warrant further considerations. Scattered throughout the study area are small acreages with possibilities of irrigation development by individual farmers or small groups. There are many areas that should be considered for future development if feasible. Future irrigation development and expansion should not be eliminated from long-range development plans considering advancements in technology, changing economic conditions, improved crop varieties, introducing specialty crops, and implementing better management.

The following tabulation displays the inventory of potential irrigable land:

Inventory of Potentially Irrigable Lands
(East-Central Oklahoma Water Supply Study, January 1985)

County	Greatest Irrigation Potential (Total acres)
Coal	23,000
Hughes	31,700
Lincoln	24,800
Okfuskee	28,000
Pawnee	18,000
Payne	22,400
Pontotoc	23,600
Pottawatomie	26,700
Seminole	22,400
Study Area Total	220,600

D. Forestry Resources

Major forest areas are located in Coal County. About 49,000 acres of commercial forest land are found in the county--86 percent hardwood and 14 percent mixed stands of hardwood and softwood. No commercial forest land data are available for the eight other counties in the study area.

Information provided to RedArk indicates that there are five primary forest products industries located in the study area--three located in Hughes County and one each in Seminole and Lincoln Counties. These industries process logs into such products as lumber, posts, poles, and wood chips. No information was provided as to the name of firm, location, number employed, or specific products. Specific information was provided concerning the 10 secondary forest products industries, employing 717 people in the study area. This information is provided in the following tabulation:

1/ Resource Assessment and Development Strategies, RedArk, October 1982.

Table VII-4
Type of Farm by Number and Value of Agricultural Products Sold - Study Area, 1982 [1]

	Study Area Totals		Coal County		Hughes County		Lincoln County		Okfuskee County	
	No. Farms	Value ($1,000)	No. Farms	Value ($1,000)	No. Farms	Value ($1,000)	No. Farms	Value ($1,000)	No. Farms	Value ($1,000)
Crops	1,977	22,610	81	289	218	4,050	425	2,387	178	1,776
Grains	1,292	11,400	20	111	137	888	273	1,191	87	918
Cotton and cottonseed	9	16	5	16	--	--	--	--	--	--
Field seeds, hay, and silage	1,038	3,505	52	99	58	155	208	666	78	185
Vegetables, sweet corn, and melons	62	84	3	2/	2	2/	8	2/	12	2/
Fruits, nuts, and berries	119	314	9	28	7	6	23	140	8	2/
Nursery and greenhouse products	29	748	--	--	1	2/	5	241	--	--
Other crops 3/	209	5,131	3	2/	94	2,984	13	2/	23	493
Livestock, poultry, and their products	8,067	124,190	547	10,195	792	8,406	1,505	19,036	674	8,494
Poultry and poultry products	228	1,210	9	4/	17	1	55	9	19	2/
Dairy products	238	19,520	18	604	7	2/	82	8,203	11	296
Cattle and calves	7,654	90,984	538	9,463	771	7,662	1,438	9,841	646	7,693
Hogs and pigs	452	2,926	27	2/	55	292	72	677	33	2/
Sheep, lambs, and wool	263	212	1	2/	17	42	41	35	3	2/
Other 5/	535	5,590	23	35	33	2/	104	272	35	2/
Total farms	9,324		589		908		1,731		745	
Market value of agricultural products sold		146,800		10,483		12,456		21,423		10,271
Average per farm	$15,744		$17,799		$13,718		$12,376		$13,786	

1/ Source: 1982 Census of Agriculture. Individual items are conservative estimates because of nonavailability and disclosure problems, thus individual items do not add up to totals.
2/ Withheld to avoid disclosing data for individual farms.
3/ Not possible to determine type of crops.
4/ Amount reported is less than half the unit value.
5/ Fish and other aquaculture products included in this category.

Table VII-4 (Continued)

Type of Farm by Number and Value of Agricultural Products Sold - Study Area, 1982 1/

	Pawnee County		Payne County		Pontotoc County		Pottawatome County		Seminole County	
	No. Farms	Value ($1,000)	No. Farms	Value ($1,000)	No. Farms	Value ($1,000)	No. Farms	Value ($1,000)	No. Farms	Value ($1,000)
Crops	267	2,986	409	4,487	151	946	302	4,097	164	1,592
Grains	221	2,702	318	3,427	43	222	157	1,468	36	473
Cotton and cottonseed	--	--	2	2/	--	--	2	2/	--	--
Field seeds, hay, and silage	91	246	158	549	107	407	170	884	116	314
Vegetables, sweet corn, and melons	8	21	9	15	2	2/	14	48	4	2/
Fruits, nuts, and berries	7	2	11	2/	14	138	25	2/	15	2/
Nursery and greenhouse products	--	--	7	11	3	71	7	425	6	2/
Other crops 3/	3	15	12	86	4	90	43	1,222	14	241
Livestock, poultry, and their products	568	15,456	984	19,110	921	19,180	1,190	15,322	886	8,991
Poultry and poultry products	22	5	38	2/	15	842	44	353	19	2/
Dairy products	3	2/	51	4,902	29	2,769	30	2,427	7	319
Cattle and calves	543	14,952	910	12,295	858	14,560	1,106	7,663	844	6,855
Hogs and pigs	21	113	83	920	55	227	73	356	33	341
Sheep, lambs, and wool	22	28	41	83	12	17	13	4	13	3
Other 4/	40	2/	75	2/	73	764	96	4,519	56	2/
Total farms	643		1,123		1,048		1,407		1,030	
Market value of agricultural products sold		18,442		23,597		20,126		19,419		10,583
Average per farm	$28,681		$21,012		$19,204		$13,802		$10,275	

1/ Source: 1982 Census of Agriculture. Individual items are conservative estimates because of nonavailability and disclosure problems, thus individual items do not add up to totals.
2/ Withheld to avoid disclosing data for individual farms.
3/ Not possible to determine type of crops.
4/ Fish and other aquaculture products included in this category.

Table VII-5
Analysis of 1981 Reported Irrigation 1/
(East-Central Oklahoma Water Supply Study, January 1985)

Crop	Study Area Summary Irrigated Acres Ground Water	Study Area Summary Irrigated Acres Surface Water	Study Area Summary Irrigated Acres Study Area Total	Coal County Irrigated Acres Ground Water	Coal County Irrigated Acres Surface Water	Coal County Irrigated Acres County Total	Hughes County Irrigated Acres Ground Water	Hughes County Irrigated Acres Surface Water	Hughes County Irrigated Acres County Total	Lincoln County Irrigated Acres Ground Water	Lincoln County Irrigated Acres Surface Water	Lincoln County Irrigated Acres County Total	Okfuskee County Irrigated Acres Ground Water	Okfuskee County Irrigated Acres Surface Water	Okfuskee County Irrigated Acres Study Area Total
Alfalfa	561	1,192	1,753	0	0	0	0	65	65	25	0	25	0	85	85
Grain corn	20	0	20	0	0	0	20	0	20	0	0	0	0	0	0
Silage corn	0	200	200	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	10	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Horticulture	3	58	61	0	0	0	0	0	0	0	0	0	0	0	0
Pasture	705	1,805	2,510	0	40	40	185	205	390	0	112	112	0	275	275
Peanuts	1,303	2,696	3,999	0	150	150	542	1,547	2,089	0	54	54	0	53	53
Wheat	300	1,034	1,334	0	0	0	50	120	170	0	0	0	0	750	750
Small grain	20	116	136	0	0	0	20	0	20	0	0	0	0	0	0
Soybeans	190	704	894	0	0	0	0	419	419	0	0	0	0	250	250
Grain sorghum	51	624	675	0	0	0	20	240	260	0	0	0	0	34	34
Forage sorghum	356	315	671	0	0	0	289	69	358	0	60	60	0	0	0
Other crops	301	491	792	0	0	0	110	123	233	12	1	13	0	40	40
Totals	3,820	9,235	13,055	0	190	190	1,236	2,788	4,024	37	227	264	0	1,487	1,487

Types of Power (Used for Irrigation)	Study Area Summary (No. of Units)	Coal County (No. of Units)	Hughes County (No. of Units)	Lincoln County (No. of Units)	Okfuskee County (No. of Units)
Propane	82	1	31	1	4
Electric	18	0	0	3	0
Natural gas	20	0	9	2	1
Gasoline	11	1	2	1	0
Diesel	17	0	7	0	0
Types of Systems (Used for Irrigation)					
Gravity	13	2	1	1	0
Trickle-drip	4	0	0	0	0
Center pivot sprinkler	14	0	3	2	0
Other sprinklers	111	0	39	4	5

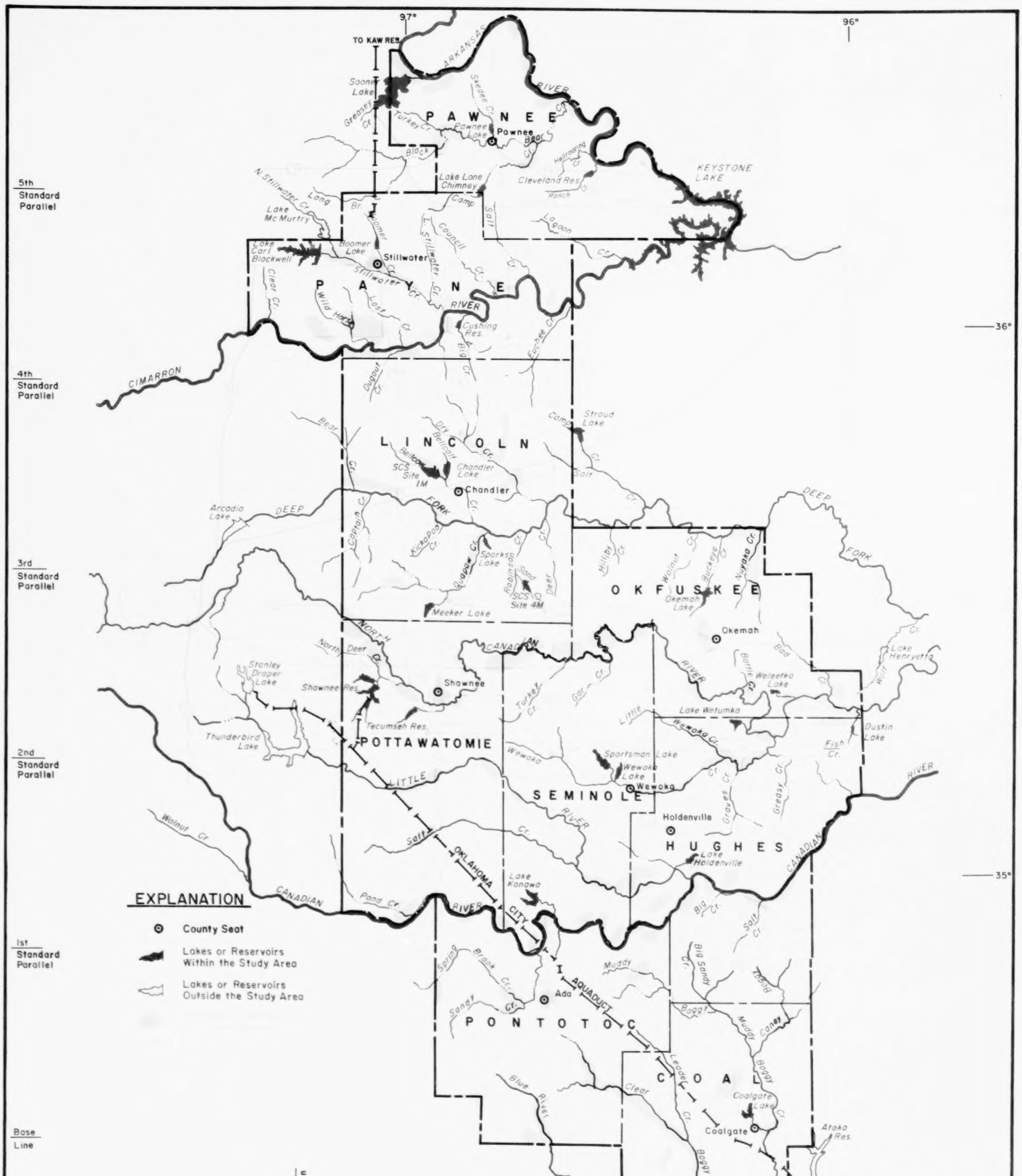
1/ Source: 1981 Reported Water Use, Oklahoma Water Resources Board, 1984.

Table VII-5 (Continued)
Analysis of 1981 Reported Irrigation [1/]
(East-Central Oklahoma Water Supply Study, January 1985)

Crop	Pawnee County			Payne County			Pontotoc County			Pottawatomie County			Seminole County		
	Irrigated Acres Ground Water	Irrigated Acres Surface Water	Irrigated Acres Study Area Total	Irrigated Acres Ground Water	Irrigated Acres Surface Water	Irrigated Acres County Total	Irrigated Acres Ground Water	Irrigated Acres Surface Water	Irrigated Acres County Total	Irrigated Acres Ground Water	Irrigated Acres Surface Water	Irrigated Acres County Total	Irrigated Acres Ground Water	Irrigated Acres Surface Water	Irrigated Acres Study Area Total
Alfalfa	0	135	135	166	48	214	150	220	370	220	639	859	0	0	0
Grain corn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Silage corn	0	0	0	0	0	0	0	200	200	0	0	0	0	0	0
Cotton	0	0	0	10	0	10	0	0	0	0	0	0	0	0	0
Horticulture	0	0	0	0	6	6	0	0	0	3	52	55	0	0	0
Pasture	0	100	100	10	60	70	510	515	1,025	0	338	338	0	160	160
Peanuts	0	0	0	30	0	30	102	0	102	476	844	1,320	153	48	201
Wheat	0	0	0	0	53	53	40	51	91	0	60	60	210	0	210
Small grain	0	0	0	0	0	0	0	80	80	0	36	36	0	0	0
Soybeans	0	0	0	10	0	10	0	0	0	180	35	215	0	0	0
Grain sorghum	0	0	0	20	0	20	11	140	151	0	210	210	0	0	0
Forage sorghum	0	0	0	0	0	0	67	146	213	0	40	40	0	0	0
Other crops	0	0	0	179	178	357	0	28	28	0	121	121	0	0	0
Totals	0	235	235	425	345	770	880	1,380	2,260	879	2,375	3,254	363	208	571

Types of Power (Used for Irrigation)	Pawnee County (No. of Units)	Payne County (No. of Units)	Pontotoc County (No. of Units)	Pottawatomie County (No. of Units)	Seminole County (No. of Units)
Propane	2	2	7	34	0
Electric	0	3	4	8	0
Natural gas	0	2	4	1	1
Gasoline	0	4	2	1	0
Diesel	0	2	3	4	1
Types of Systems (Used for Irrigation)					
Gravity	0	4	2	3	0
Trickle-drip	0	1	1	2	0
Center pivot sprinkler	0	1	4	4	0
Other sprinklers	2	8	15	36	2

[1/] Source: 1981 Reported Water Use, Oklahoma Water Resources Board, 1984.


97°
96°
TO KAW RES.
Sooner Lake
PAWNEE
Pawnee
Pawnee Lake
ARKANSAS RIVER
Skeleton Cr.
Turkey Cr.
Greasey Cr.
Black Bear
Hellroaring Cr.
KEYSTONE LAKE
Lake Lone Chimney
Cleveland Res.
Ranch
5th Standard Parallel
N. Stillwater Cr.
Long
Lake McMurtry
Br.
Boomer
Camp
Council
Salt
Lagoon
Lake Carl Blackwell
Boomer Lake
Stillwater
Stillwater Cr.
PAYNE
Clear Cr.
Wild Horse
Lost Cr.
RIVER
Cushing Res.
Big Cr.
Euchee Cr.
Cr.
36°
CIMARRON
4th Standard Parallel
Dugout Cr.
Bear
Dry Bellcow
Camp
Stroud Lake
LINCOLN
Bellcow
SCS Site 1M
Chandler Lake
Chandler
Salt
Cr.
FORK
DEEP
Arcadia Lake
Captain Cr.
Kickapoo Cr.
Quapaw Cr.
Sparks Lake
Robinson
Sand
Deer
SCS Site 4M
3rd Standard Parallel
Meeker Lake
Hillby Cr.
Walnut Cr.
Buckeye Cr.
Nuyaka Cr.
OKFUSKEE
Okemah Lake
Okemah
DEEP FORK
Lake Henryetta
Wolf Cr.
Bad
Battle Cr.
Weleetka Lake
NORTH
North Deer
CANADIAN
Stanley Draper Lake
Shawnee Res.
Shawnee
Tecumseh Res.
Thunderbird Lake
POTTAWATOMIE
Turkey Cr.
Gar Cr.
Little
RIVER
Lake Wetumka
Wewoka Cr.
Dustin Lake
Fish Cr.
2nd Standard Parallel
Wewoka
Sportsman Lake
Wewoka Lake
Wewoka
SEMINOLE
LITTLE
Graves Cr.
Gressy Cr.
RIVER
Holdenville
HUGHES
Lake Holdenville
CANADIAN
Walnut Cr.
Salt
RIVER
Cr.
OKLAHOMA CITY AQUADUCT
Lake Konawa
35°
CANADIAN
Pond Cr.
RIVER
EXPLANATION
County Seat
Lakes or Reservoirs Within the Study Area
Lakes or Reservoirs Outside the Study Area
1st Standard Parallel
Big Cr.
Salt Cr.
Spring Brook Cr.
Muddy
Big Sandy Cr.
Sandy Cr.
Ada
Boggy
Muddy
Caney
PONTOTOC
Leader Cr.
Clear
COAL
Boggy Cr.
Blue River
Coalgate Lake
Coalgate
Atoka Res.
Base Line
Boggy Cr.
Indian Meridian
OKLAHOMA
STUDY AREA
LOCATION MAP
N
1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
10 0 10 20
SCALE OF MILES
10 0 10 20 30
SCALE OF KILOMETERS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

GENERAL AREAS OF GREATEST
IRRIGATION POTENTIAL

Amarillo, Texas January, 1985
Map No. 1484-500-12

Secondary Forest Products Industries
(East-Central Oklahoma Water Supply Study, January 1985)

County	Name and Location of Firm	Number of People Employed	Products Produced
Hughes	Boise Cascade Corporation Holdenville, Oklahoma	150	Manufactured homes
Payne	Custom Production Company Stillwater, Oklahoma	5	Pallets and hose reels
	Glencoe Manufacturing Company Glencoe, Oklahoma	7	Cellulose fiber loose-fill insulation and cellulose fiber spray-on insulation
	The Lee Company (J.G. Industries, Inc.) Stillwater, Oklahoma	40	Wood products, windows, mirrors, ladders, and scaffolding
Pontotoc	Brockway Glass Company, Inc. Ada, Oklahoma	458	Corrugated paper boxes
	Chief Pallet Corporation Roff, Oklahoma	5	Hardwood pallets and skids
	Greens Glass and Decorating Ada, Oklahoma	9	Wood products, mirrors, and picture frames
	Scott Manufacturing Company Ada, Oklahoma	13	Church furniture
Pottawatomie	Bison Lumber & Hardware, Inc. Shawnee, Oklahoma	12	Wood cabinets
	Shawnee Planing Mill, Inc. Shawnee, Oklahoma	18	Architectural woodwork

Based on information provided by RedArk, optimum development of forestry resources has been restricted because little is known about the ownership, location, and use of privately owned forest lands; the region lacks hardwood timber markets; few furniture industries are found in the region, thus most of the quality hardwood lumber produced is shipped out of the area; and there is no regional group or organization actively promoting timber utilization and forest industry development.

E. Problems and Needs

Agriculture has not been developed as much in the study area as it has in other areas of the State. The average value of agricultural products sold per farm in the study area in 1981 equalled only 45 percent of the State average. Agricultural experts 1/ maintain that excessive numbers of small and inefficient farms, the large number of part-time farm operations, and the predominant over-emphasis on livestock production are major causes of the area's poor agricultural income performance. Most recommended solutions involve increased and more efficient production of harvested crops as a primary solution with increased efficiency in livestock production as a secondary solution.

Within this context, the problems, needs, and solutions Reclamation plans to address during the remaining 3-1/2 years of this study are:

1. Investigate potential for development of irrigated specialty crop enterprises. Reclamation will work with OSU, SCS, county agents, and other agriculturalists in this area.

2. Continue to investigate the potential for Federal project-type irrigation development in the study area and make appropriate recommendations based on findings.

3. Investigate, develop, and demonstrate more efficient irrigation management methods.

4. Fully investigate the potential for development of forest products. Although the potential for primary forest products industries may be limited due to limited forest resources, there is a need to encourage additional secondary forest products industries in the study area since it presently contains one-third of the State's firms engaged in such enterprises.

1/ Source: Resource Assessment and Development Strategies, RedArk, October 1982.

CHAPTER VIII - INDUSTRIAL DEVELOPMENT

A. Introduction

Reclamation's 9-county study area included in this planning guide is part of RedArk's 24-county project area. To see the relationship between the two areas, refer back to map No. 1484-500-28 in chapter I. As part of its ongoing efforts in comprehensive economic development, RedArk published the report Resource Assessment and Development Strategies in October of 1982. Although large portions of Reclamation's east-central study are relatively well off compared to the southeastern portion of RedArk's project area, many of the characteristics, problems, and solutions apply to varying degrees in the east-central study area. Therefore, the material in this chapter is taken from two parts of the above report. The first portion deals with manufacturing employment characteristics, which suggest manufacturing sectors that hold promise for additional development or revival in the study area. The second portion deals with the topic of industrial development.

B. Manufacturing Employment Characteristics

1. Analysis of data. Accurate time series comparisons of detailed industry classifications are impossible at this time due to lack of complete, comparable data. 1/ However, some generalizations are possible by use of the data which are available. Significant, identifiable trends appear in eight industries: (a) apparel; (b) wood products; (c) printing and publishing; (d) petroleum; (e) rubber and plastics products; (f) stone, clay, and glass; (g) fabricated metals; and (h) nonelectrical machinery.

a. Apparel--Cut and sew apparel manufacturing accounted for a minimum of 17.8 percent of total manufacturing employment in 1969. By 1979, apparel's share had fallen to 9.6 percent of total. In the United States, apparel captured 6.3 percent of manufacturing employment during 1979. Apparel manufacturing is a necessary part of the United States industrial structure; but at the same time, apparel manufacture is a low-skill/low-wage industrial group.

b. Wood products--Sawmills employed 3.1 percent of the area's manufacturing workers in 1979, with other wood products industries accounting for another 2.5 percent. At least 7.8 percent of 1969 manufacturing employment was in wood products. Therefore, wood products manufacture is significantly less important to the area's economy than it was in the previous decade. This is surprising in light of the slight growth of the furniture sector estimated during the period.

c. Printing and publishing--This sector exhibited astounding growth in the project area during 1969 to 1979. In 1969, this sector represented at most 4.0 percent of manufacturing employment, but by 1979 its importance had grown to 14.4 percent. In the United States during 1979, printing and publishing accounted for only 5.9 percent of manufacturing employment. The printing and publishing industry pays average annual wages slightly below the manufacturing average and was impacted much less by the 1974-1975 recession than the overall manufacturing sector. 2/ The printing and publishing industry is expected to grow at a real rate of about 3.0 percent per year through the mid-1980's and, hence, may outpace the growth of the United States economy.

d. Petroleum--The petroleum industry's share of manufacturing employment fell considerably in the 1969-1979 period, accounting for at least 4.0 percent of 1969 employment and for only 2.0 percent in 1979. This trend is serious since petroleum is the highest wage-manufacturing industry in the United States, paying average annual wages of $19,400 in 1978. In addition to high wages, the United States petroleum industry has had stable employment growth throughout the 1969-1979 period except for 1974-1975 when employment fell by 1.5 percent. 3/ There is no reason to expect this favorable trend to end in the near future.

In short, the project area should attempt to revive a sagging petroleum sector to secure the high-pay/high-growth benefits associated with the industry.

e. Rubber and plastics products--The rubber and plastics products industry, like the petroleum industry, saw its share of the project area economy halved in the decade of the 1970's, falling from 5.7 percent in 1969 to only 2.8 percent in 1979. This industrial group pays wages below the manufacturing average and was one member of the nondurable goods grouping which was severely affected by the 1974-1975 recession, falling 12.5 percent in terms of employment. The industry did not recover to prerecession employment levels until 1977.

Although the rubber and plastics products industry does not have outstanding growth characteristics or potential through the 1980's, southeastern Oklahoma is fortunate to have a disproportionate share of the miscellaneous plastics products industry. This segment of the industry grew at a 6.9 percent annual rate in the 1972-1978 period, and the use of miscellaneous plastics products in almost every manufacturing industry should ensure the long-term growth of this detailed industry grouping. While the rubber and plastics products industry will not be an outstanding growth industry through the 1980's, the project area's concentration of miscellaneous plastics products employment should provide the basis for stable long-term growth in this sector of the economy.

f. Stone, clay, and glass--This group is the largest sector of the manufacturing base of the project area, accounting for 14.6 percent of total manufacturing employment in 1979. This sector accounted for as little as 4.7 percent of manufacturing employment during 1969. The stone,

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1/ Data limitations necessitate a bracketing of many industries' employment as a percent of total for 1969, with wood products as one. More than 7.8 percent and less than 14.0 percent of manufacturing employment was in wood products during 1969.

2/ Employment in manufacturing fell 8.7 percent in the 1974-1975 period, compared to only 2.5 percent in the printing and publishing industry.

3/ Recall, however, that overall manufacturing employment fell by almost 9.0 percent during this recessionary period.

clay, and glass industry ranks below the overall manufacturing average annual wage and is considered a low-skill industry in spite of the fact that several segments of the group are operated by skilled craftsmen (i.e., glassblowing and tombstone carving). The industry seems to be very susceptible to national business cycles as industry employment fell 11.1 percent in the national recession of 1974-1975.

The majority of stone, clay, and glass employment located in southeastern Oklahoma is in the ready-mixed concrete industry, which is tied strongly and directly to the construction industry. Therefore, the project area should be prepared for a period of instability in this sector as the construction industry tries to recover from the recession of the early 1980's.

g. Fabricated metals--The fabricated metals industry accounted for 9.3 percent of manufacturing employment in 1979 with no comparable figure available for 1969. 1/ The industry is very cyclical, with employment falling by 11.0 percent during 1974-1975. The industry pays wages slightly above the manufacturing average, and skill levels are commensurate with the industry wage.

However, a major factor for the industry in southeastern Oklahoma is the McAlester Army Ammunition Plant in Pittsburg County. The Oklahoma State Industrial Directory, 1982 lists employment at this plant as 800, making it the largest fabricated metals employer in the project area. This installation is essentially Government in nature and is not responsive to activity in the United States economy. Thus, the fabricated metals industry's growth in southeastern Oklahoma is difficult to predict and depends primarily upon the national defense budget.

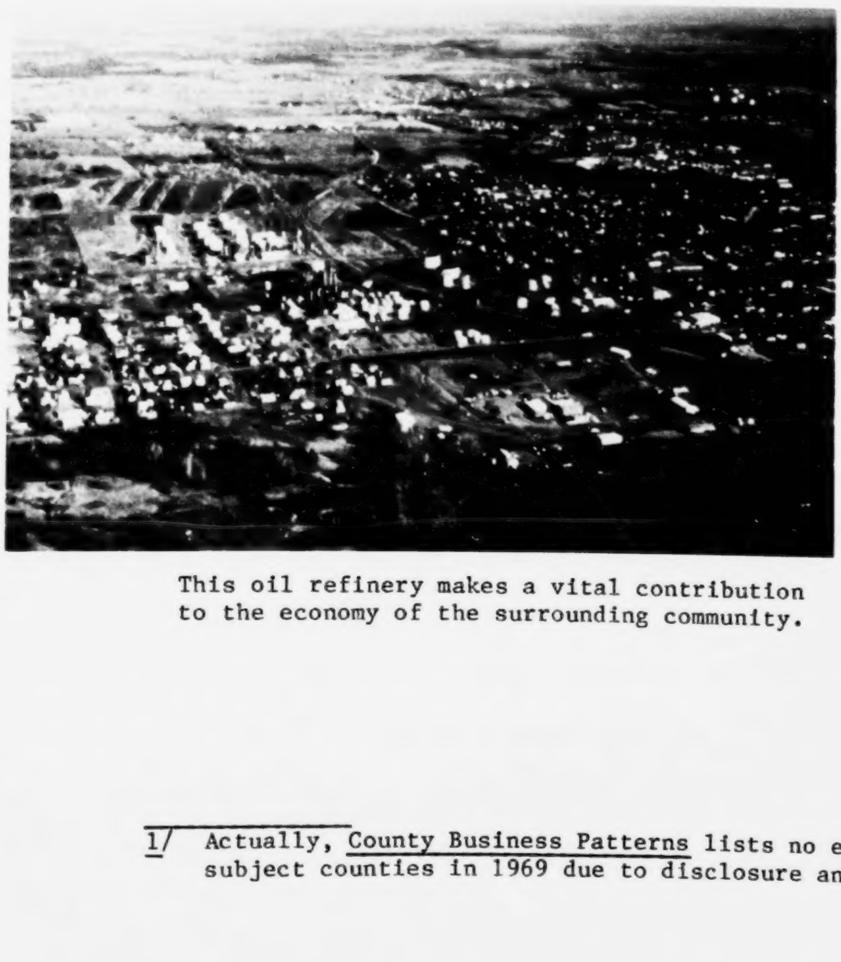
h. Nonelectrical machinery--This industry saw its share of project area manufacturing employment grow from less than 2.0 percent in 1969 to slightly more than 8.0 percent in 1979. The industry is a high-wage/high-skill group which has posted good historical growth and is forecast to continue this trend. Notable among the detailed industries present in southeastern Oklahoma are farm machinery, oilfield machinery, and machine tool accessories, all of which have good growth prospects through the 1980's.

2. General conclusions. The manufacturing sector of the southeastern Oklahoma economy is playing a larger role in the overall economic activity of the region today than it did in 1969. However, this region still trails the Nation in industrial activity. Several "growth" sectors are present such as nonelectrical machinery, instruments, and electrical machinery. These industries should be actively recruited since they are the type of industry which has located in the region during the last decade and, at the same time, can contribute most to productivity and income growth in the project area.

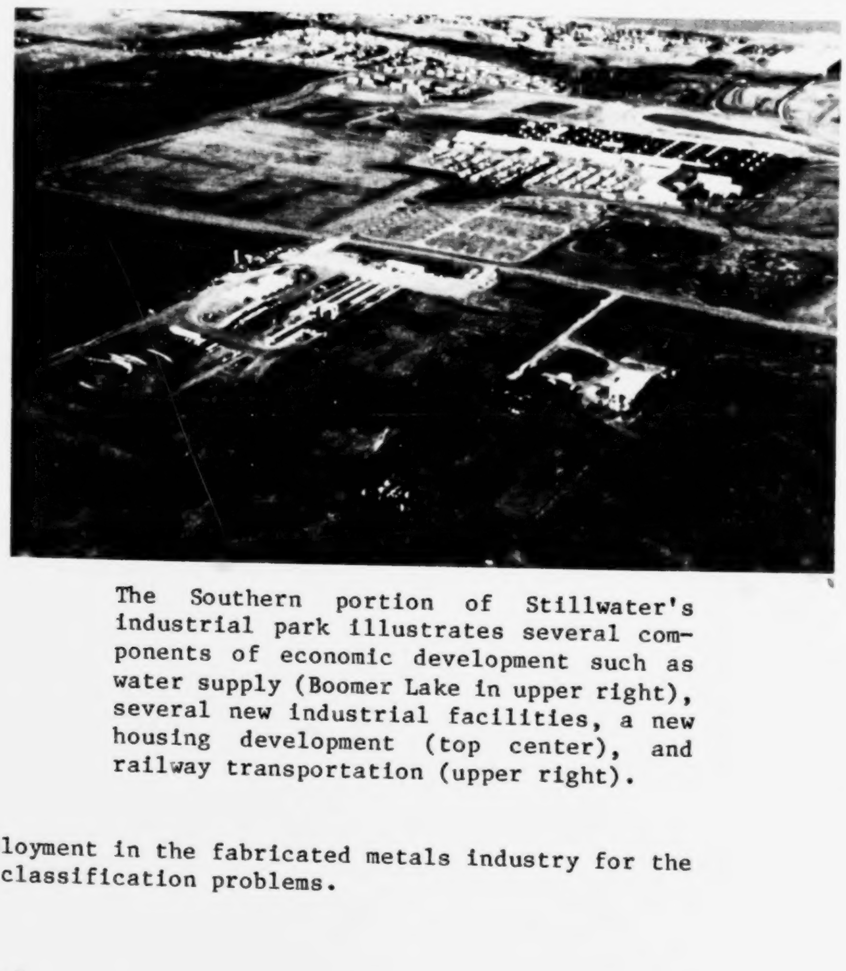
C. Industrial Development

1. Introduction/Methodology. The economy of the 24-county RedArk project area is less developed than that of the State or the United States as a whole. There are substantially fewer employment opportunities in the manufacturing and trades and services sectors of the project area economy, which have kept per capita incomes significantly below State and national averages. Higher than average percentages of employment exist in agriculture and State and local government as a result of this phenomenon. Working age residents are continuing to leave the project area in search of employment, especially those who have earned high school and post-high school degrees. In order to strengthen the economy of the project area, more effort needs to be focused on the creation of new job opportunities in the manufacturing sector which will, in turn, generate more employment in the trades and services sector and improve the balance and overall health of the area economy.

The three Sub-State Planning Districts--COEDD, the Kiamichi Economic Development District of Oklahoma (KEDDO), and SODA--assisted in assessment of the project area's existing industrial development patterns and strategies and in investigation of the potential for stimulating more activity. The districts were asked to conduct inventories of (a) existing industrial sites, including the number of acres and utilities available to each location, (b) local industrial development organizations in the district, and (c) existing manufacturing firms in the area and the employment levels for each firm.



This oil refinery makes a vital contribution to the economy of the surrounding community.

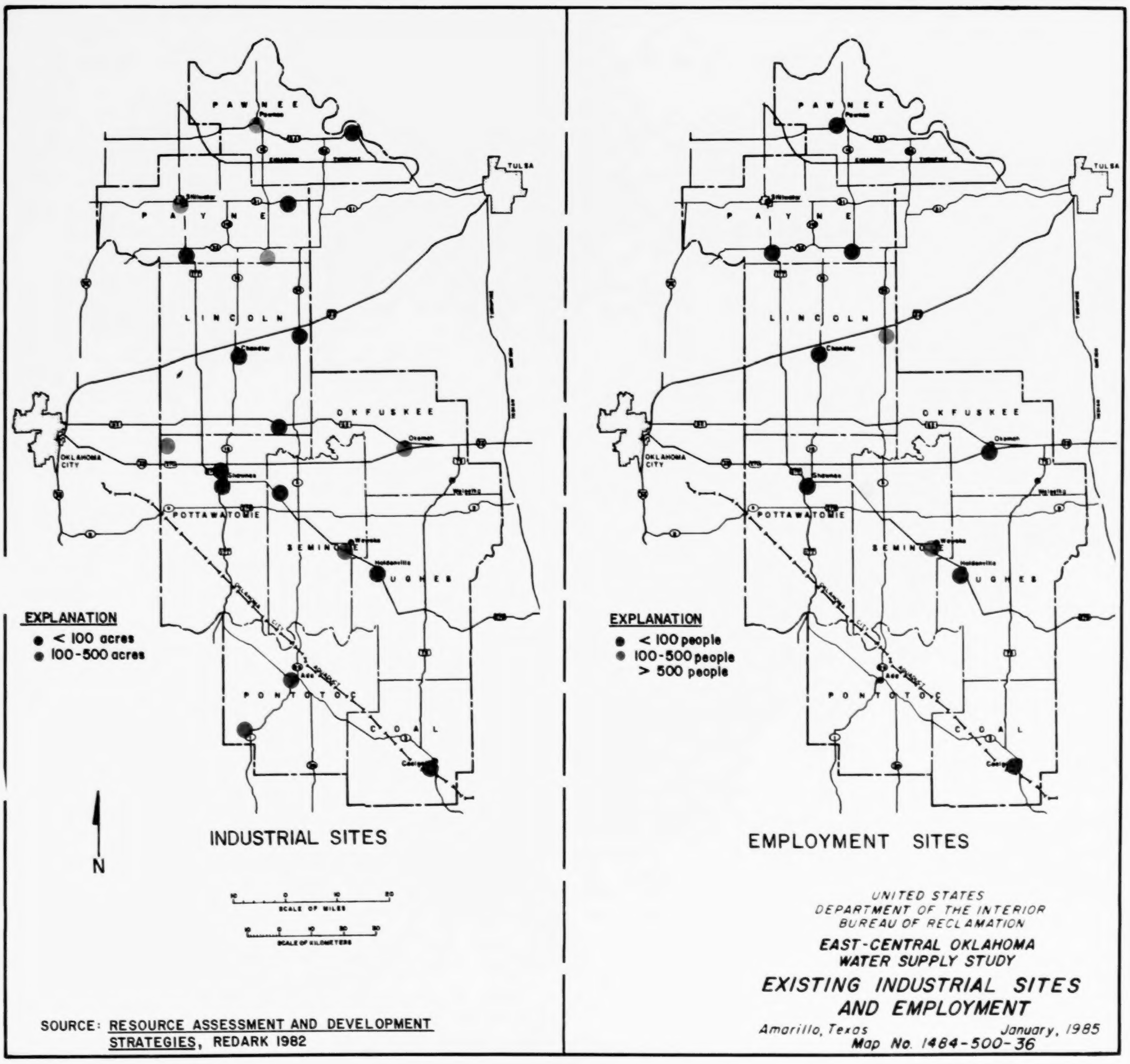


The Southern portion of Stillwater's industrial park illustrates several components of economic development such as water supply (Boomer Lake in upper right), several new industrial facilities, a new housing development (top center), and railway transportation (upper right).

1/ Actually, County Business Patterns lists no employment in the fabricated metals industry for the subject counties in 1969 due to disclosure and classification problems.

Interviews were conducted with officials of the State Department of Economic and Community Affairs and Department of Economic Development to gain a better understanding of their roles in stimulating additional job opportunities in the project areas. Principals of the Rural Enterprise Development Corporation (REDC) and the Industrial Technology Research and Development Center (ITRAD) were also interviewed to ensure that any recommendations made took into consideration the innovative job creation efforts recently undertaken by these groups.

2. Extent of the resource. The inventory of existing manufacturing activity and infrastructure to support additional industrial development indicates that the project area is not homogeneous. Map No. 1484-500-36 indicates the location of existing industrial sites and manufacturing employment in Reclamation's nine-county east-central study area. There is a dichotomy which presently exists in the 24-county area. The western portion of the project area, in the immediate vicinity of Interstate 35, the corridor between Oklahoma City and Dallas, and the larger population bases in the area have naturally had better success in attracting manufacturing activity than the remaining counties. The western counties have also made more investments in additional industrial acreage, presumably because they have witnessed the benefits of new manufacturing activity to their local economies.


PAWNEE
PAYNE
LINCOLN
OKFUSKEE
POTTAWATOMIE
SEMINOLE
HUGHES
PONTOTOC
COAL
TULSA
OKLAHOMA CITY
Chandler
Okemah
Shawnee
Wewoka
Holdenville
Ada
Coalgate
EXPLANATION
● < 100 acres
● 100-500 acres
N
INDUSTRIAL SITES
SCALE OF MILES
SCALE OF KILOMETERS
EXPLANATION
● < 100 people
● 100-500 people
> 500 people
EMPLOYMENT SITES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY
EXISTING INDUSTRIAL SITES
AND EMPLOYMENT
Amarillo, Texas
January, 1985
Map No. 1484-500-36

SOURCE: RESOURCE ASSESSMENT AND DEVELOPMENT STRATEGIES, REDARK 1982

This dichotomy exists because the western portion of the project area has natural advantages which other parts of the project area do not--good access to highway transportation networks, relatively large concentrations of population, and available investment capital which springs from past development successes. This phenomenon requires that different development strategies be employed--a more basic effort in those counties without the above advantages and a more advanced effort in those counties which have already experienced some success in industrial development.

The REDC and ITRAD have been established in recognition of the fact that much of the project area has not benefited from traditional industrial development recruitment efforts. These organizations focus on more innovative ways to create job opportunities. Among the strategies employed by REDC and ITRAD are the creation of new businesses based on the development of new technology or technology transfer, assistance to existing businesses trying to expand in the project area, stimulating the creation of new jobs by obtaining vendor contracts from large industries, providing financial consultations and packaging assistance, and providing sources of debt and equity capital to help finance new ventures. In addition, REDC has established three industry incubators in area vocational technical schools to help train prospective employees before new firms are established to help increase the success rate of new enterprises in the region. An entrepreneurship curriculm has also been established in the vocational technical schools to promote a greater understanding of the free enterprise system. The REDC and ITRAD represent bold new initiatives in economic development which take into account the problems with the project area economy and attempt to focus resources on areas which can create jobs despite the economic development barriers which exist.

This report focuses on still other means to stimulate the creation of new employment opportunities in the project area. The reasons that traditional industrial development efforts have not succeeded throughout the region are analyzed and ways to improve the use of existing resources to strengthen the region's economic base are discussed.

3. Barriers to industrial development. Industrial development is a highly competitive process. When a manufacturing firm decides to expand or relocate, it can choose among any number of areas which are fully prepared to meet the firm's requirements for sites--transportation of both raw material and finished products, energy, and a properly trained labor force. In most instances, the firm can also secure financial or tax inducements which lower the cost of relocation. Today's national economic difficulties have made this process even more competitive.

Most communities in the project area are presently at a competitive disadvantage in attracting new firm locations or expansions because of some or all of the following barriers:

a. Transportation networks--Poor transportation networks severely limit the desirability of much of the eastern portion of the project area. The lack of four-lane, divided United States highways or interstates into the project area from major metropolitan areas such as Tulsa, Oklahoma City, or Dallas negatively affects the marketability of sites in far southeastern Oklahoma.

b. Labor force--Lack of a sufficiently large and well-trained labor force also presents a barrier to the development of many communities in the project area. Those few communities with populations over 10,000 in the project area dramatically underscore this point.

c. Existing infrastructure--Lack of existing infrastructure such as industrial sites with water, sewer, natural gas, electricity, and rail access also serves to hinder the area's competitive posture. The western portion of the area is far better prepared in this regard than other areas of the project area.

d. Housing and other social factors--Lack of local amenities such as adequate housing, good public or private schools, and social and recreation opportunities also poses a significant barrier to some of the area's smaller communities. Firms traditionally show considerable interest in this matter because of the concerns of management employees typically imported to manage operations.

A good transportation network is vital to economic development. Pictured is the Highway 18 - Turner Turnpike (I-44) intersection. Note toll gate in the center foreground and rest area in the upper right section.

The Seminole, Oklahoma, industrial park was designed to integrate into the total community.

e. Industrial promotion for the study area--Lack of an organized industrial promotion effort for the project area is another major barrier. No single agency or group actively promotes the project area for industry location. The State Department of Economic Development provides location services and shows any prospective sites throughout the State, which often brings to light the competitive disadvantages of communities in the project area. Some local industrial development groups in the area are active in recruiting, but most are limited financially in the ability to actively promote the community.

4. Considerations to stimulate industrial development. In view of the project area's need to stimulate new employment opportunities and taking into account the dichotomy which exists within the project area itself, the following considerations are made:

a. Since the far eastern portion of the project area and several other small communities are at a much more serious competitive disadvantage with regard to stimulating new job opportunities, a basic approach to economic development preparedness could be demonstrated in one or two communities next year. The demonstrations should involve organizing the community's leadership, assessing the community's resources and specific barriers which are preventing economic growth from occurring, and working with the community leadership to determine a logical sequence of development efforts which can place the community in a more competitive position. The Oklahoma Gas and Electric Company (OG&E) and development districts have ongoing technical assistance programs which should be integrated into these demonstrations.

b. A Regional Industrial Development Association (RIDA) could be established to work with interested counties and communities in the project area to aggressively promote the creation of new jobs in the area. The RIDA concept has been successful in other areas of the country, especially the Tennessee Valley, in augmenting the ongoing efforts of existing State and local efforts. A small professional staff of trained industrial developers should be assembled and an annual operating budget of approximately $100,000 should be elicited from local governments interested in participating. The RIDA staff's primary responsibility would be to serve as the primary interface between industrial prospects and candidate communities, working to provide prospects with pertinent information and to help communities put their "best foot forward" in the recruitment effort. The RIDA can also assist REDC and ITRAD in efforts to secure vendor contract work for communities in the project area and can make valuable use of the financial packaging assistance and financial resources being assembled by these organizations.

c. Training seminars could be developed and conducted for interested communities and local industrial groups, explaining ever-changing financing arrangements; ways to emphasize a community's advantages and commitment to development, services, and facilities which most prospects require; etc. These seminars could be conducted by the RIDA in conjunction with the outreach efforts of REDC and ITRAD.

d. Arrangements could be made with an area university or research center to provide market analyses and feasibility studies in support of an aggressive industrial promotional effort. These services are often critical in attracting industrial firms and must be available on a timely basis.

e. Members of the educational system in the project area should be involved in any industrial development efforts so they would have adequate notice to establish curricula and specific training programs which would enhance the area's labor force availability for specific prospects.

CHAPTER IX - WATER RESOURCES

A. Surface Water Hydrology (General)

The following data are for average climatic and hydrologic conditions in the study area:

1. Rainfall averages about 36 inches (see map No. 1484-500-23),
2. Runoff averages 300 $\frac{\text{acre-ft/yr}}{\text{mi}^2}$ or 5.5 inches (map No. 1484-500-23),
3. Pan evaporation averages 70 inches (map No. 1484-500-23),
4. Lake evaporation averages 50 inches,
5. Growing season averages 210 days, and
6. Mean annual temperature is about 61° F.

Thunderstorms produce a large portion of the annual rainfall. However, some of these thunderstorm systems become violent and capable of producing damaging winds, hail, and tornados.

Several major streams traverse the study area. The Arkansas River makes up the northeastern border of Pawnee County. Keystone Lake on the eastern edge of Pawnee County regulates the flow of the Arkansas and the next major stream, the Cimarron River. The Deep Fork, North Canadian, and Canadian Rivers all flow west to east across the area. These streams are all part of the Arkansas River Basin. Coal County and part of Pontotoc County are within the Red River Basin.

The Arkansas River, a major study area stream, as it enters Keystone Lake. Note powerplant that uses the reservoir for cooling water supplies.

The Cimarron River, another major stream, as it traverses the middle portion of Payne County.

Streamflow, rainfall, and reservoir yield rates increase from west to east and from north to south in the study area. Except for Keystone Lake, there are no large reservoirs in the area. There are many small to modest size reservoirs that serve the needs for recreation, M&I water supply, livestock water, powerplant cooling, etc.

Table IX-1 summarizes surface water gauge records in and around the area. Map No. 1484-500-24 shows the location of many of these gauges. Not all of the stream records listed in the table are in the study area. However, the data in the table represent the data available for use in analyzing streamflow and reservoir yield in the study area.

As mentioned before, runoff averages about 300 $\frac{\text{acre-ft/yr}}{\text{mi}^2}$ in the study area. This ranges from about 150 $\frac{\text{acre-ft/yr}}{\text{mi}^2}$ in northwestern Payne and Pawnee Counties to about 650 $\frac{\text{acre-ft/yr}}{\text{mi}^2}$ in southeastern Coal County. This wide variance in runoff is mirrored by the rainfall distribution in the area.

Map No. 1484-500-6 shows the location of existing surface water resources in the study area. As can be seen, Keystone Lake is the only large lake in the study area. There are numerous small to modest size reservoirs in the area that serve to meet recreation and water use needs. Table IX-2 lists the principal reservoirs in the study area and some pertinent data for each site. Reservoir yield estimates have been derived for these reservoirs. The values represent total firm yield 1/ at the

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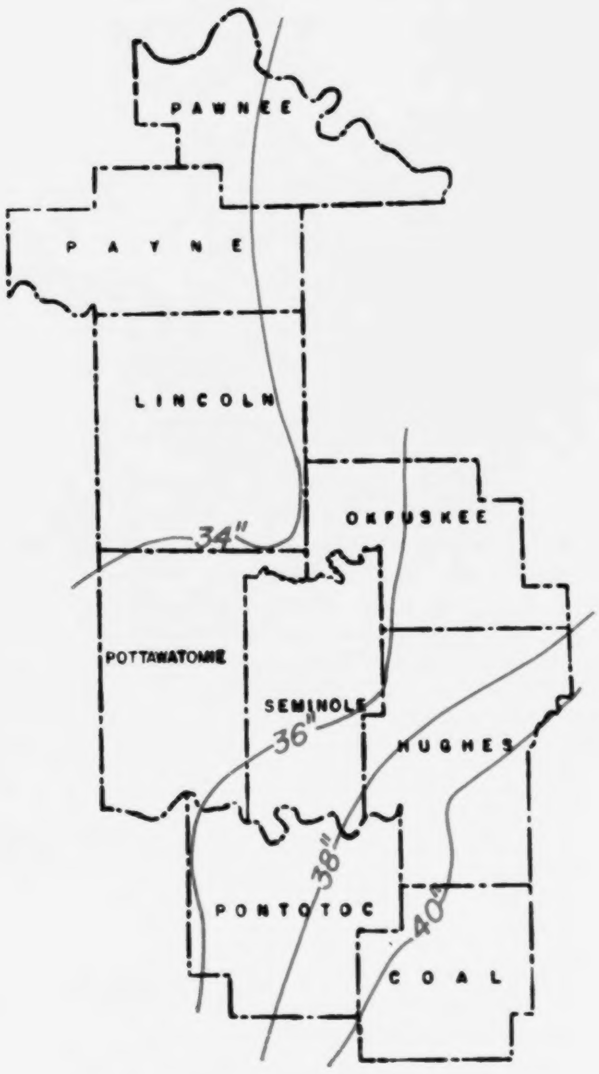
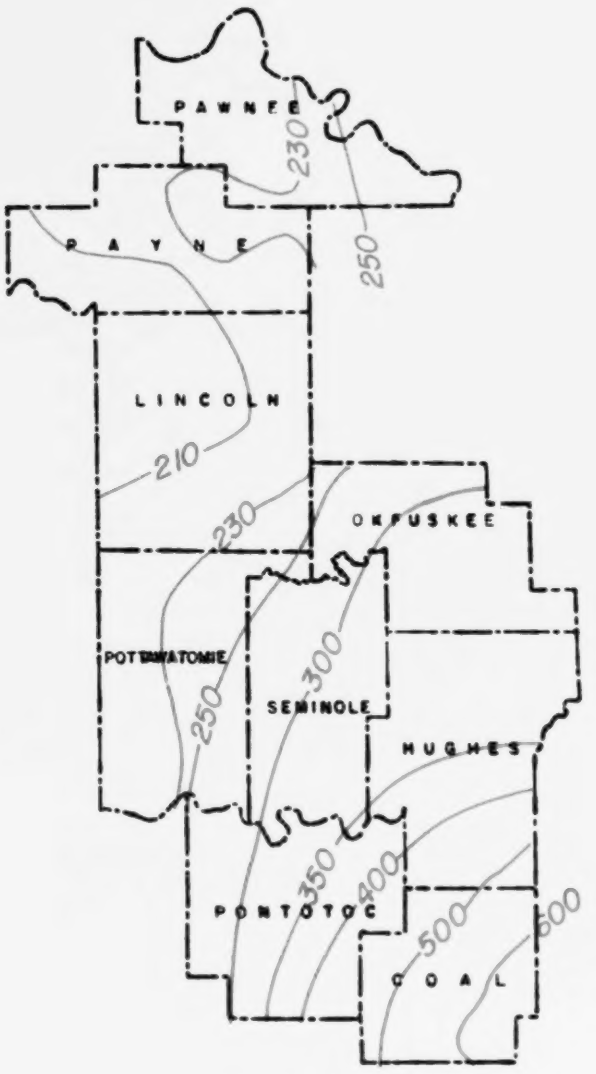
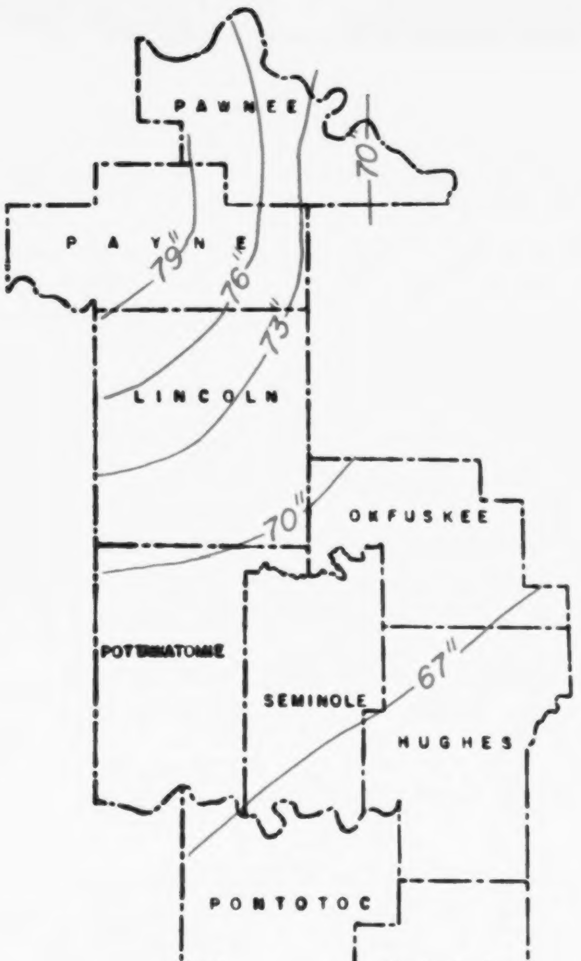
1/ Firm yield is the largest amount of water that can be annually withdrawn from a reservoir of specific size based on the inflow patterns established during the worst drought of record. This definition applies to the calculated values shown in table IX-2. Estimated values shown in the table are not the result of specific inflow studies and reservoir operations. They are an estimation of firm yield based on comparison with calculated values in the surrounding area.


PAWNEE
PAYNE
LINCOLN
34"
OKFUSKEE
POTTAWATOMIE
SEMINOLE
36"
HUGHES
38"
PONTOTOC
40"
COAL

Average Annual Precipitation
Period 1951-80


PAWNEE
230
250
PAYNE
LINCOLN
210
230
OKFUSKEE
POTTAWATOMIE
300
SEMINOLE
250
HUGHES
350
400
PONTOTOC
500
600
COAL

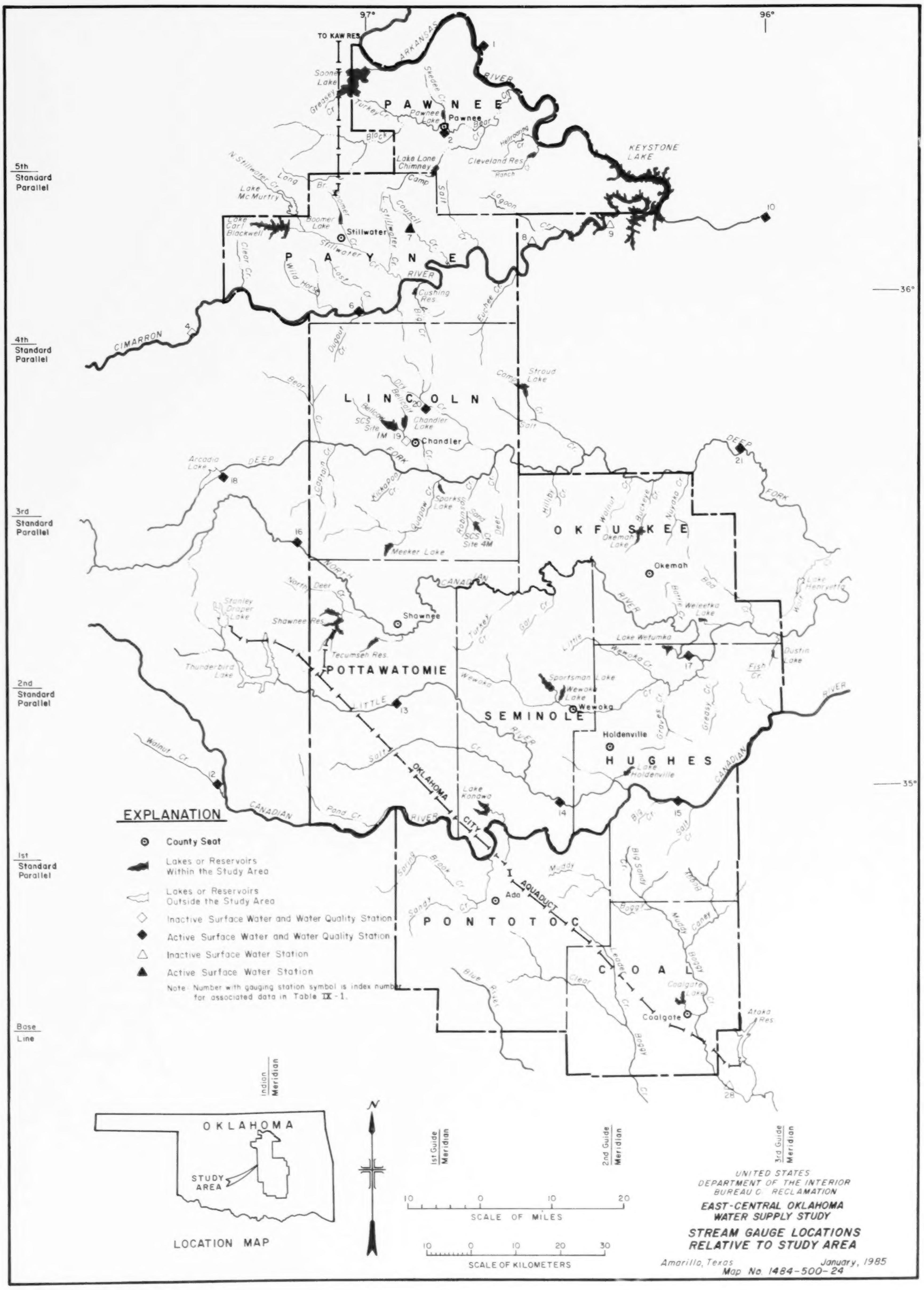
Average Annual Runoff
acre-feet/sq. mile/year


PAWNEE
70
PAYNE
79"
76"
73"
LINCOLN
70"
OKFUSKEE
POTTAWATOMIE
67"
SEMINOLE
HUGHES
PONTOTOC
COAL
67"

Average Annual Pan Evaporation

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY
GENERALIZED HYDROLOGIC
CHARACTERISTICS
Amarillo, Texas January, 1985
Drawing No. 1484-500-23


97°
96°
TO KAW RES
Sooner Lake
Greasey Cr
ARKANSAS
RIVER
Skedee Cr
Turkey Cr
PAWNEE
Pawnee Lake
Pawnee
Bear Cr
Black
Hellroaring Cr
KEYSTONE LAKE
Cleveland Res
Ranch
Lake Lone Chimney
Camp
Salt
Lagoon
Cr
5th Standard Parallel
N. Stillwater Cr
Long Br
Lake McMurtry
Boomer Cr
Boomer Lake
L. Stillwater Cr
Council Cr
Lake Carl Blackwell
Stillwater
PAYNE
Stillwater Cr
Clear Cr
Wild Horse Cr
Lost Cr
RIVER
Cushing Res
Big Cr
Euchee Cr
CIMARRON
4th Standard Parallel
36°
Dugout Cr
Bear Cr
Camp
Stroud Lake
LINCOLN
Dry Cr
Bellcow Cr
Chandler Lake
SCS Site 1M
Chandler
Salt Cr
Arcadia Lake
DEEP
FORK
Captain Cr
Kickapoo Cr
Quapaw Cr
Sparks Lake
Robinson Cr
Sand Cr
Deer
SCS Site 4M
Meeker Lake
3rd Standard Parallel
Hillibi Cr
Walnut
Buckeye
Nuyaka Cr
OKFUSKEE
Okemah Lake
Okemah
DEEP
FORK
Bad
Lake Henryetta
Wolf Cr
NORTH
North Deer Cr
CANADIAN
Stanley Draper Lake
Shawnee Res
Shawnee
Tecumseh Res
Thunderbird Lake
POTTAWATOMIE
Turkey Cr
Gar Cr
Little
RIVER
Barnes Cr
Weleetka Lake
Lake Wetumka
Wewoka Cr
Fish Cr
Dustin Lake
Sportsman Lake
Wewoka Lake
Wewoka
2nd Standard Parallel
LITTLE
Wewoka
SEMINOLE
RIVER
Cr
Holdenville
HUGHES
Lake Holdenville
Graves Cr
Greasy Cr
RIVER
CANADIAN
Walnut Cr
Salt
OKLAHOMA CITY AQUADUCT
Lake Konawa
35°
CANADIAN
Pond Cr
RIVER
Big Cr
Salt
Big Sandy Cr
Muddy
Spring Brook Cr
Sandy Cr
Ada
Boggy
Muddy
Caney
Boggy
PONTOTOC
Leader Cr
COAL
Clear
Cr
Boggy
Coalgate Lake
Cr
Coalgate
Atoka Res
Blue River
1st Standard Parallel
Base Line
Indian Meridian
1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
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28
EXPLANATION
County Seat
Lakes or Reservoirs Within the Study Area
Lakes or Reservoirs Outside the Study Area
Inactive Surface Water and Water Quality Station
Active Surface Water and Water Quality Station
Inactive Surface Water Station
Active Surface Water Station
OKLAHOMA
STUDY AREA
LOCATION MAP
N
10 0 10 20
SCALE OF MILES
10 0 10 20 30
SCALE OF KILOMETERS

Note: Number with gauging station symbol is index number for associated data in Table IX-1.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

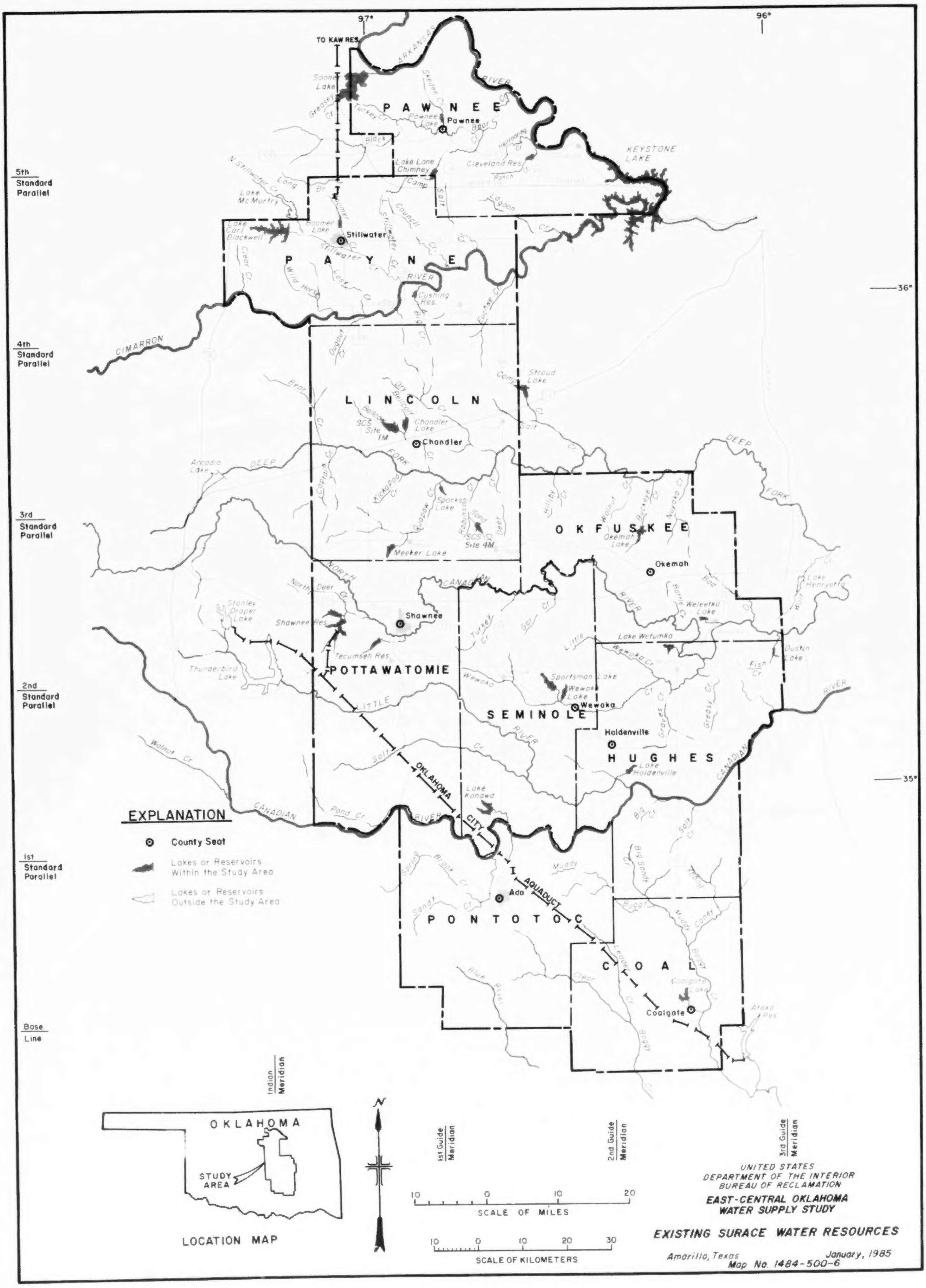
EAST-CENTRAL OKLAHOMA WATER SUPPLY STUDY

STREAM GAUGE LOCATIONS RELATIVE TO STUDY AREA

Amarillo, Texas January, 1985
Map No. 1484-500-24

Table IX-1
Streamflow Records In and Around the Study Area
(East-Central Oklahoma Water Supply Study, January 1985)

Index for map No. 1484-500-24	Stream Gauge	Total Drainage Area (mi^2)	Noncontributing Drainage area (mi^2)	USGS Station No.	Average Streamflow Unregulated (acre-ft/yr)	Average Streamflow Regulated (acre-ft/yr)	Period of Record
Arkansas River Basin							
1	Arkansas River at Ralston	54,465	7,615	07152500	3,496,000	2,494,000	Oct 1925 to present, regulation since 1975 by Kaw Reservoir.
2	Black Bear Creek at Pawnee	576	—	07153000	123,200	—	July 1944 to present.
	Cottonwood Creek at Seward	316	—	07159750	90,560	—	March 1973 to present.
4	Cimarron River near Guthrie	16,892	4,926	07160000	644,100	—	Oct 1937 to Sept 1976.
	Skeleton Creek near Lovell	410	—	07160500	82,590	—	Oct 1949 to present.
6	Cimarron River near Perkins	17,852	4,926	07161000	835,300	—	June 1939 to present.
7	Council Creek near Stillwater	31	—	07163000	7,820	—	March 1934 to present.
8	Cimarron River at Oilton	18,669	4,926	07163500	900,600	—	Oct 1934 to Sept 1945.
9	Cimarron River at Manford	18,849	4,926	07164000	1,292,300	—	Oct 1948 to Sept 1950 and Oct 1959 through June 1963.
10	Arkansas River at Tulsa	74,615	12,541	07164500	4,745,000	4,919,000	Oct 1925 to present, regulated since 1964 by Keystone Reservoir.
11	Polecat Creek below Heyburn Dam	123	—	07165500	48,470	35,140	Oct 1943 to Sept 1979, regulated since 1950 by Heyburn Reservoir.
12	Walnut Creek at Purcell	202	—	07229300	32,240	—	Oct 1950 to Sept 1955, Oct 1958 to Sept 1965 (occasional records), and Oct 1965 to present.
13	Little River near Tecumseh	456	—	07230500	107,900	52,450	Oct 1943 to present, regulation since March 1965 by Lake Thunderbird.
14	Little River near Sasakwa	865	—	07231000	288,400	166,600	Sept 1942 to present, regulation since March 1965 by Lake Thunderbird.
15	Canadian River at Calvin	27,952	4,801	07231500	1,098,000	—	July 1944 to present.
16	North Canadian River near Harrah	13,501	4,899	07241550	—	197,000	Oct 1968 to present, regulated by Lakes Canton and Overholser.
17	North Canadian River near Wetumka	14,290	4,899	07242000	—	469,500	Oct 1937 to present, regulation by Lakes Overholser (1917) and Canton (April 1948).
18	Deep Fork near Arcadia	105	—	07242350	46,370	—	Oct 1969 to present.
19	Bellcow Creek at Chandler	46	—	07242500	9,000	—	July 1948 to Sept 1955.
20	Dry Creek near Kendrick	69	—	07243000	14,420	—	Oct 1955 to present.
21	Deep Fork near Beggs	2,018	—	07243500	565,800	—	Sept 1938 to present.
Red River Basin							
	Washita River near Pauls Valley	5,330	—	07328500	489,800	—	Oct 1937 to present, some regulation by Fort Cobb Reservoir (1959), Foss Reservoir (1961), and SCS structures.
	Wildhorse Creek near Hoover	604	—	07329700	118,100	—	Oct 1969 to present.
	Rock Creek at Dougherty	138	—	07329900	46,000	—	March 1956 to June 1967.
	Washita River near Dickson	7,202	—	07331000	978,800	—	Aug 1928 to present, some regulation by Fort Cobb Reservoir (1959), Foss Reservoir (1961), Arbuckle Reservoir (1963) and SCS structures.
	Blue River at Milburn	203	—	07332400	94,180	—	Oct 1965 to present.
	Coal Creek near Lehigh	8.5	—	07332900	2,050	—	Oct 1977 to Sept 1981.
28	Muddy Boggy Creek at Atoka	445	—	07332950	131,700	—	Oct 1978 to Sept 1981.
	Chicksaw Creek near Stringtown	32.7	—	07333500	22,000	—	Oct 1955 to Sept 1968.
	McGee Creek near Stringtown	86.6	—	07333800	65,000	—	April 1956 to Sept 1968.
	McGee Creek near Farris	176	—	07333910	95,900	—	Oct 1977 to May 1982.
	Muddy Boggy Creek near Farris	1,087	—	07334000	626,000	—	Oct 1937 to present, some regulation by Atoka Reservoir since June 1959.
	Clear Boggy Creek near Caney	720	—	07335000	336,200	—	Oct 1942 to present.


97°
96°
36°
35°
TO KAW RES.
5th Standard Parallel
4th Standard Parallel
3rd Standard Parallel
2nd Standard Parallel
1st Standard Parallel
Base Line
PAWNEE
Pawnee
Pawnee Lake
Sooner Lake
ARKANSAS RIVER
KEYSTONE LAKE
Lake Lone Chimney
Cleveland Res.
PAYNE
Stillwater
Boomer Lake
Lake McMurtry
Lake Carl Blackwell
Cushing Res.
CIMARRON RIVER
LINCOLN
Chandler
Chandler Lake
Stroud Lake
SCS Site 1M
Sparks Lake
SCS Site 4M
Meeker Lake
Arcadia Lake
DEEP FORK
OKFUSKEE
Okemah
Okemah Lake
Lake Henryetta
Weleetka Lake
Lake Wetumka
Dustin Lake
POTTAWATOMIE
Shawnee
Shawnee Res.
Tecumseh Res.
Stanley Draper Lake
Thunderbird Lake
NORTH CANADIAN RIVER
SEMINOLE
Wewoka
Wewoka Lake
Sportsman Lake
HUGHES
Holdenville
Lake Holdenville
LITTLE RIVER
CANADIAN RIVER
Lake Konawa
OKLAHOMA CITY AQUADUCT
PONTOTOC
Ada
COAL
Coalgate
Coalgate Lake
Atoka Res.
Clear Boggy Cr.
Muddy Boggy Cr.
Blue River
EXPLANATION
County Seat
Lakes or Reservoirs Within the Study Area
Lakes or Reservoirs Outside the Study Area
Indian Meridian
1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
OKLAHOMA
STUDY AREA
LOCATION MAP
N
10 0 10 20
SCALE OF MILES
10 0 10 20 30
SCALE OF KILOMETERS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

EXISTING SURACE WATER RESOURCES

Amarillo, Texas January, 1985
Map No. 1484-500-6

Table IX-2
Existing Water Supply Reservoirs
(East-Central Oklahoma Water Supply Study, January 1985, Revised March 1985)

County/Reservoir Name	Contributing Drainage Area	Water Usage Purpose 1/	Water Surface Area	Conservation Storage	Flood Control Storage	Permit Usage	Principal Water Use Entity	Total Firm Yield 1/	Firm Supplies Available In Study Area Before 1990	
	(mi²)		(acres)	(acre-feet)	(acre-feet)	(acre-ft/yr)		(acre-ft/yr)	(acre-ft/yr)	(Mgal/d)
Coal County										
Coalgate	14	M	352	3,000	4,974	3,000	Coalgate	E 2,000	2,000	1.785
Hughes County										
Dustin	2.2	M	28	205	440	— 5/	Dustin	E 150	150	0.134
Henryetta	20.4	M	616	6,660	11,550	10,585	Henryetta 2/	E 4,000	45 2/	0.040 2/
Holdenville	9.3	M	550	11,000	15,600	3,150	Holdenville	E 2,300	2,300	2.053
Wetumka	4.2	M	185	2,000	3,260	307	Wetumka	E 800	800	0.714
Lincoln County										
Chandler	5.3	M	330	2,778	4,334	882	Chandler	E 530	530	0.473
Meeker	11.4	M, R, FW	117	1,548 3/	3,739	67	Meeker	C 201	201	0.179
Kickapoo Nations Site - 1M	32.6	M	-- 5/	8,390	-- 5/	-- 5/	Chandler (under constr.)	C 4,557	4,557	4.068
Robinson Creek Site - 4M	6.7	M, R	225	1,700	1,680	-- 5/	Prague	C 550	550	0.491
Sparks	.58	M	16	150	174	22	Sparks	C 27	27	0.024
Stroud	16.2	M, R, FW	586	8,000 3/	4,994	500	Stroud	C 1,300	1,300	1.161
Okfuskee County										
Okemah	20.2	M	720	10,800	26,200	1,779	Okemah	E 3,300	3,300	2.946
Weleetka	2.1	M	60	385	620	233	Weleetka	E 200	200	0.179
Pawnee County										
Cleveland	21.6	M	64	2,212	—	2,450	Cleveland	E 750	750	0.670
Keystone	22,351	M, FC, P, FW	55,320	20,000	1,218,500	22,400	Corps of Engineers	C 22,400	-- 4/	-- 4/
Lake Lone Chimney	26.3	M, FC	550	4,210	6,490	— 5/	Tri-County Dev. Auth.	C 2,507	2,507	2.238
Pawnee	13	M	257	3,855	—	560	Pawnee	E 950	950	0.848
Sooner	-- 5/	P, FC, R	-- 5/	149,000	47,500	3,600	Oklahoma Gas & Electric	-- 6/	-- 6/	-- 6/
Payne County										
Boomer	9	P	260	2,486	--	— 5/	Stillwater	-- 6/	— 6/	-- 6/
Carl Blackwell	75 5/	M, R	3,380	55,000	0	7,000 7/	OSU at Stillwater	C 7,000	7,000	6.249
Cushing	--	M	440	4,567	--	3,250	Cushing	E 1,800	1,800	1.607
McMurtry	25.27	M, FC, R	1,155	13,500	5,000	3,000	Stillwater	C 3,000	3,000	2.678
Kaw	7,250	M, FC, P, FW	17,000	428,600	1,348,000	— 5/	Corps of Engineers 8/	C 187,000	14,560 8/	13.000 8/
Pontotoc County - NONE										
Pottawatomie County										
Shawnee	32.5	M	2,436	34,000	0	8,000	Shawnee	E 3,700	3,700	3.303
Tecumseh	4.8	M	127	1,118	2,370	455	Tecumseh	E 350	350	0.312
Seminole County										
Konawa	11.8	P	1,100	12,500	41,000	8,000	Oklahoma Gas & Electric	-- 6/	-- 6/	-- 6/
Sportsman	12.7	FW, R	355	4,000	5,430	3,000	Oklahoma Fish & Game	E 1,800	-- 9/	-- 9/
Wewoka	12.0	M	200	3,301	9,070	998	Wewoka	E 1,000	1,000	0.893

1/ Abbreviations: M = municipal, FC = flood control, P = power cooling, R = recreation, FW = fish & wildlife; E = estimated; and C = calculated.

2/ Lake is in Okmulgee County. Salem RWC purchases water to serve four counties, two of which are in study area (Hughes and Okfuskee). Assumed only 0.040 Mgal/d available due to treatment plant capacity limits. Reservoir capability to meet future demands not yet evaluated.

3/ Data provided included specific storage allocation for recreation and/or fish and wildlife.

4/ Extreme fluctuation of reservoir pool during normal operations would require pipeline at dam outlet works near Tulsa, which has thus far been found cost prohibitive.

5/ Not yet determined or readily available.

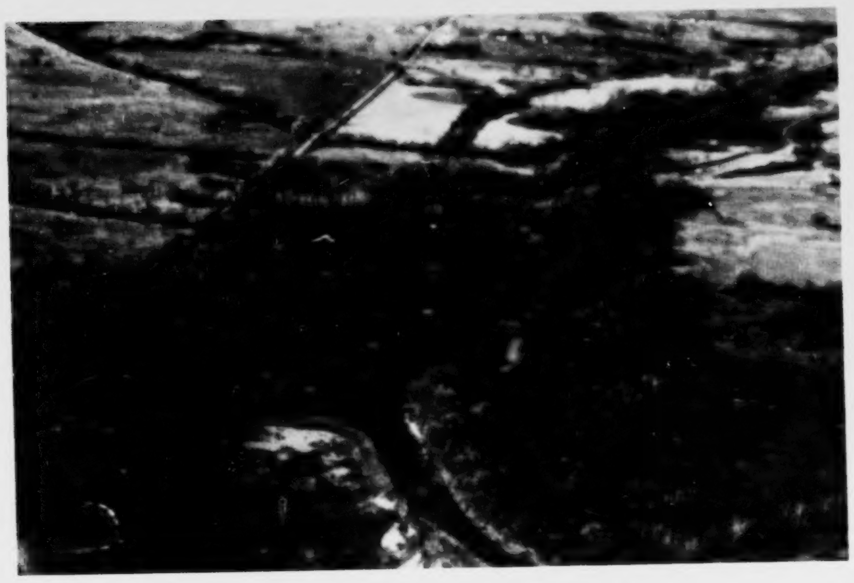
6/ Cooling reservoir.

7/ Permitted maximum withdrawal rate.

8/ Reservoir is in Osage County. Stillwater has contract to purchase and import up to 50 Mgal/d. Present plans for the future are to import up to 13 Mgal/d.

9/ Exclusively built for purposes of fish, wildlife, and recreation. No municipal supply allocation.

sites. A separate column shows the amount of the yield available in the study area (the full yields of Kaw and Henryetta Reservoirs are not listed because they are located outside the study area, and other demands are placed on their supplies). As denoted on the table, some of the yields are the result of calculations that were done when the sites were planned and constructed. However, most of the yields were estimated by making use of the limited amounts of data available for the various sites. These preliminary estimates will be reviewed as the study progresses and will be revised as necessary based on any additional data that may be found. Water permit amounts are also shown in the table. These amounts generally differ from the yield estimate because they reflect approved permit applications and the application may be based on anticipated needs rather than analysis of the source capability.



The Deep Fork is another important stream in the study area, shown here as it flows through the middle of Lincoln County. Note stockwater dugout and flood protection embankment in the lower left.

A scenic reach of the North Canadian River in Okfuskee County. Note Weleetka Lake in the upper center.

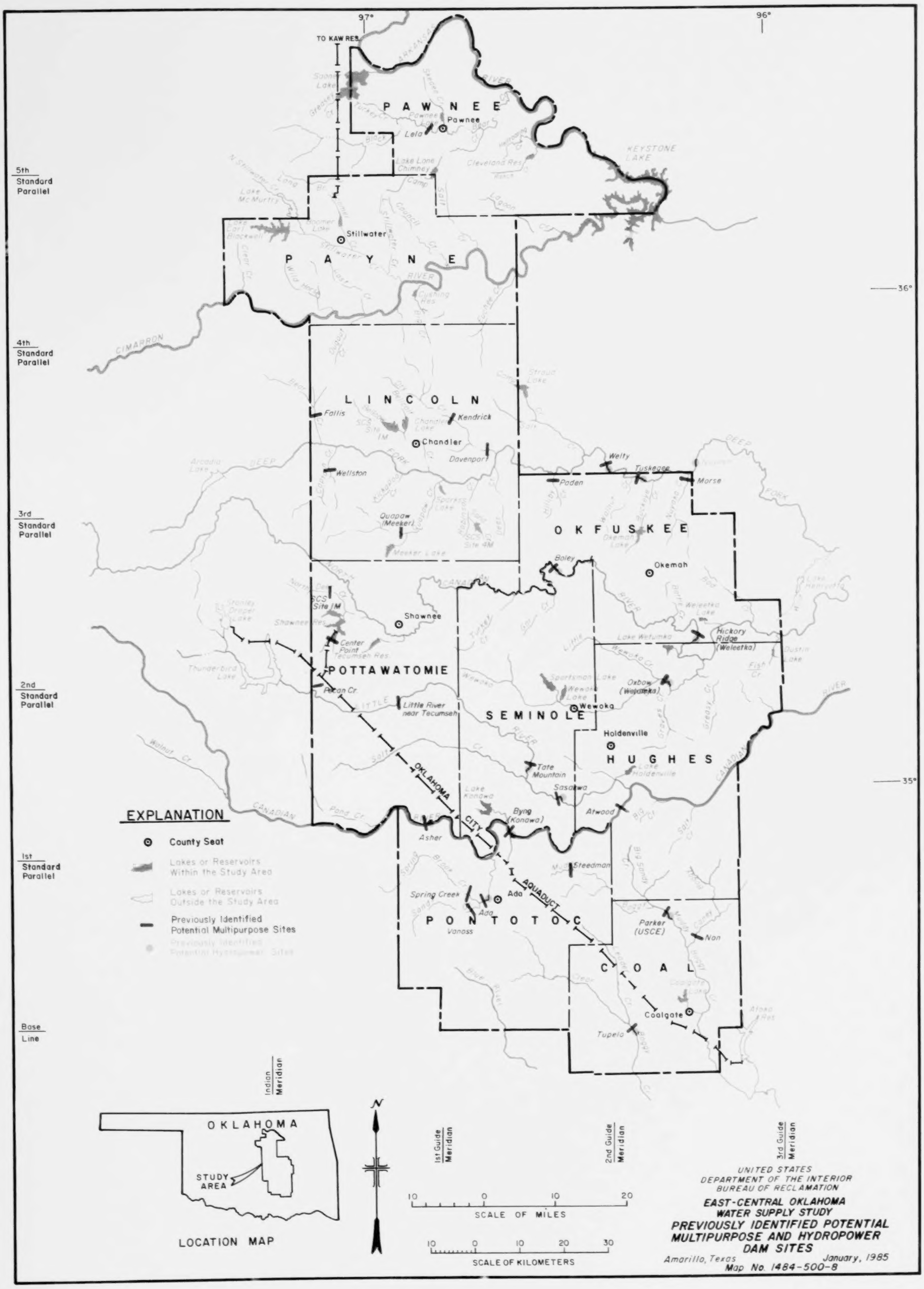
Information for previously identified potential reservoirs is displayed in table IX-3. Location of their associated damsites may be found on map No. 1484-500-8. These are sites that have been identified in the past as possible locations for development. The list is not meant to be the final word on potential sites. As the study progresses and demand centers are more firmly defined, other new sites may become more attractive for development. The estimates of yield and conservation storage were developed in a very general manner except for Lela, Parker, and the SCS North Deer Creek Watershed Site 1M. These sites have existing reservoir yield studies, and those results are reflected in the table. Detailed studies for the remaining reservoirs will be undertaken only for the sites that are required after the analysis of demand is completed, demand centers are identified, and water supply alternatives are formulated.

Yield and storage estimates shown in table IX-3 may differ from other published or documented estimates. The values shown are not the final results. They are initial planning estimates calculated by areal estimating procedures. They show the potential for yield at each site, but the estimates do not account for extenuating conditions in the watersheds such as water rights or the operation of downstream reservoirs. For example, the effects of such potential reservoirs as Atwood and Welty on the operations at Eufaula were not considered at this time. If needed, those analyses will be done in future studies. Also, the effects of the tributary reservoirs above such sites as Welty were likewise not considered. Those refinements were not a part of these initial estimates. In summary, these are generic estimates of water development potential that will be refined as firm plans emerge.

B. Ground Water Hydrology (General)

1. Geological background. Ground water aquifers are geological formations containing sustained quantities of water. It is appropriate, therefore, to provide some general geological background to assist in understanding the description of each aquifer. The information presented has been abstracted from the 1980 Oklahoma Comprehensive Water Plan. Map No. 1484-500-16 shows the geological formations in the study area as well as a geologic time scale.

> Most of the rocks that outcrop in Oklahoma are of sedimentary origin, consolidated from sediments deposited during the Paleozoic era and covering about 75 percent of the state. Locally, some Paleozoic formations achieve a thickness of 40,000 feet. The oldest of these are the Precambrian granites and rhyolites formed 1.05 to 1.35 billion years ago. Precambrian and Cambrian igneous and metamorphic rocks underlie all of the state, and provide the 'floor' upon which all younger rocks rest.
>
> The three principal mountain belts--southern Oklahoma's Ouachitas, Arbuckles and Wichitas--were formed by folding, faulting and uplift during the Pennsylvanian period. North of these mountain uplifts lie the deep Anadarko and Arkoma basins, and still farther north, the relatively undisturbed shelf areas of northern Oklahoma.



UNITED STATES
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EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY
PREVIOUSLY IDENTIFIED POTENTIAL MULTIPURPOSE AND HYDROPOWER DAM SITES

Amarillo, Texas *January, 1985*
Map No. 1484-500-8

97°
96°
36°
35°
TO KAW RES.
5th Standard Parallel
4th Standard Parallel
3rd Standard Parallel
2nd Standard Parallel
1st Standard Parallel
Base Line
Indian Meridian
1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
PAWNEE
PAYNE
LINCOLN
OKFUSKEE
POTTAWATOMIE
SEMINOLE
HUGHES
PONTOTOC
COAL
ARKANSAS RIVER
CIMARRON RIVER
DEEP FORK
NORTH CANADIAN
LITTLE RIVER
CANADIAN
KEYSTONE LAKE
Sooner Lake
Pawnee
Lela
Lake Lone Chimney
Cleveland Res.
Stillwater
Lake McMurtry
Lake Carl Blackwell
Boomer Lake
Cushing Res.
Stroud Lake
Fallis
Kendrick
Chandler
Chandler Lake
SCS Site 1M
Davenport
Wellston
Arcadia Lake
Sparks Lake
Quapaw (Meeker)
SCS Site 4M
Meeker Lake
Welty
Tuskegee
Morse
Paden
Okemah Lake
Okemah
Boley
Weleetka Lake
Hickory Ridge (Weleetka)
Lake Wetumka
Dustin Lake
Lake Henryetta
Stanley Draper Lake
Shawnee Res.
SCS Site 1M
Shawnee
Center Point
Tecumseh Res.
Thunderbird Lake
Pecan Cr.
Little River near Tecumseh
Sportsman Lake
Wewoka Lake
Wewoka
Oxbow (Weleetka)
Holdenville
Lake Holdenville
Tate Mountain
Sasakwa
Lake Konawa
Byng (Konawa)
Atwood
Asher
OKLAHOMA CITY AQUADUCT
Steedman
Spring Creek
Ada
Vanoss
Parker (USCE)
Non
Coalgate Lake
Coalgate
Tupelo
Atoka Res.
Walnut Cr.
Salt Cr.
Pond Cr.
Clear Boggy
Muddy Boggy
Big Sandy Cr.
EXPLANATION
County Seat
Lakes or Reservoirs Within the Study Area
Lakes or Reservoirs Outside the Study Area
Previously Identified Potential Multipurpose Sites
Previously Identified Potential Hydropower Sites
N
10 0 10 20
SCALE OF MILES
10 0 10 20 30
SCALE OF KILOMETERS
OKLAHOMA
STUDY AREA
LOCATION MAP

Table IX-3

Previously Identified Potential Reservoirs - Storage and Yield Estimates

(East-Central Oklahoma Water Supply Study, January 1985)

Damsite	Drainage Area	Average Basin Precipitation	Estimated Storage	Estimated Firm Yield
	(mi^2)	(inches)	(acre-feet)	(acre-ft/yr)
Lela	545	32	199,200	48,400 1/
Fallis	94	33	33,000	9,900
Wellston	58	33	25,000	7,700
Kendrick	82	35	28,000	7,800
Davenport	176	36	67,000	18,500
Quapaw	69	34.5	33,000	9,200
Paden	39	37	19,000	5,200
Welty	1,387	35	600,000	166,000 2/
Tuskegee	1,500	35	650,000	180,000 2/
Morse	84	39	58,000	16,000
Centerpoint	7.4	35	3,000	700
Boley	1,575	33	680,000	189,000 2/
Hickory Ridge	1,789	33	775,000	215,000 2/
Oxbow	343	40	265,000	74,000
Tate Mountain	342	37	180,000	44,500
Sasakwa	613	37	325,000	80,000
Asher	21,660 (est.)	30	500,000	400,000 2/
Byng	21,960 (est.)	30	500,000	400,000 2/
Atwood	22,110 (est.)	30	500,000	400,000 2/
Steedman	27	40.5	24,000	6,600
Spring Creek	46	39	31,000	8,700
Vanoss	63	39	43,000	12,000
Ada	195	39	135,000	37,000
Parker	172	41	114,650	47,000 3/
Non	94	41.5	71,000	27,000
Tupelo	380	40.5	280,000	93,000 3/
Nuyaka	2,146	35	--	-- 4/
North Deer Creek Site - 1M	38.5	35	10,082	2,020 5/
Pecan Creek	32	35	15,000	3,360 6/
Little River near Tecumseh	200	35	175,000	16,800 6/

1/ Information from Reclamation studies for State Water Plan.

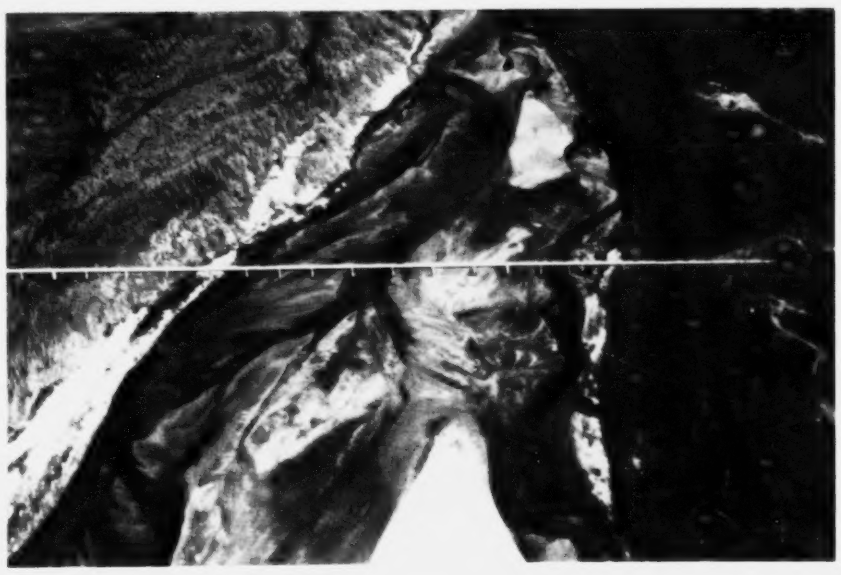
2/ These yield and storage estimates were made without consideration for existing downstream reservoir operations (Eufaula Power, Arkansas Navigation, etc.)

3/ Corps of Engineers yield study results.

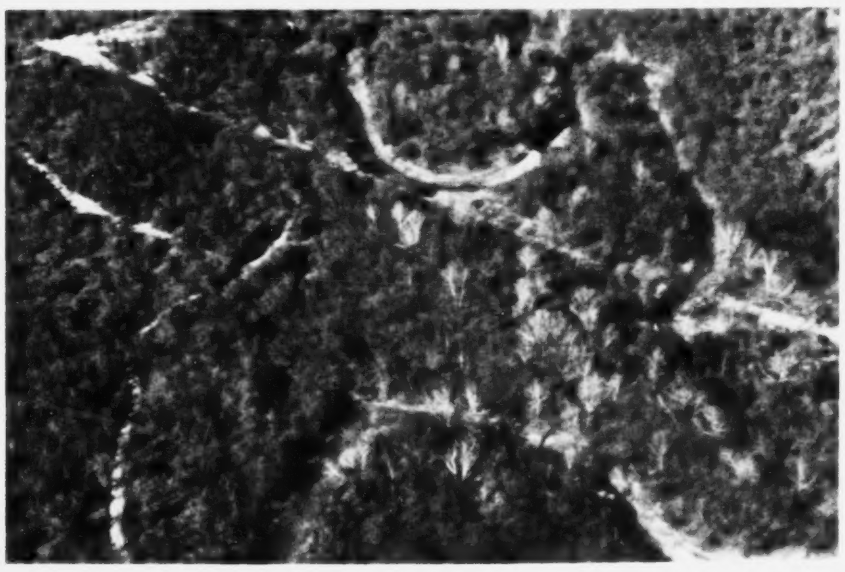
4/ Yield and storage not estimated; this site will be evaluated for hydropower potential.

5/ Yield and storage data from SCS critical yield studies.

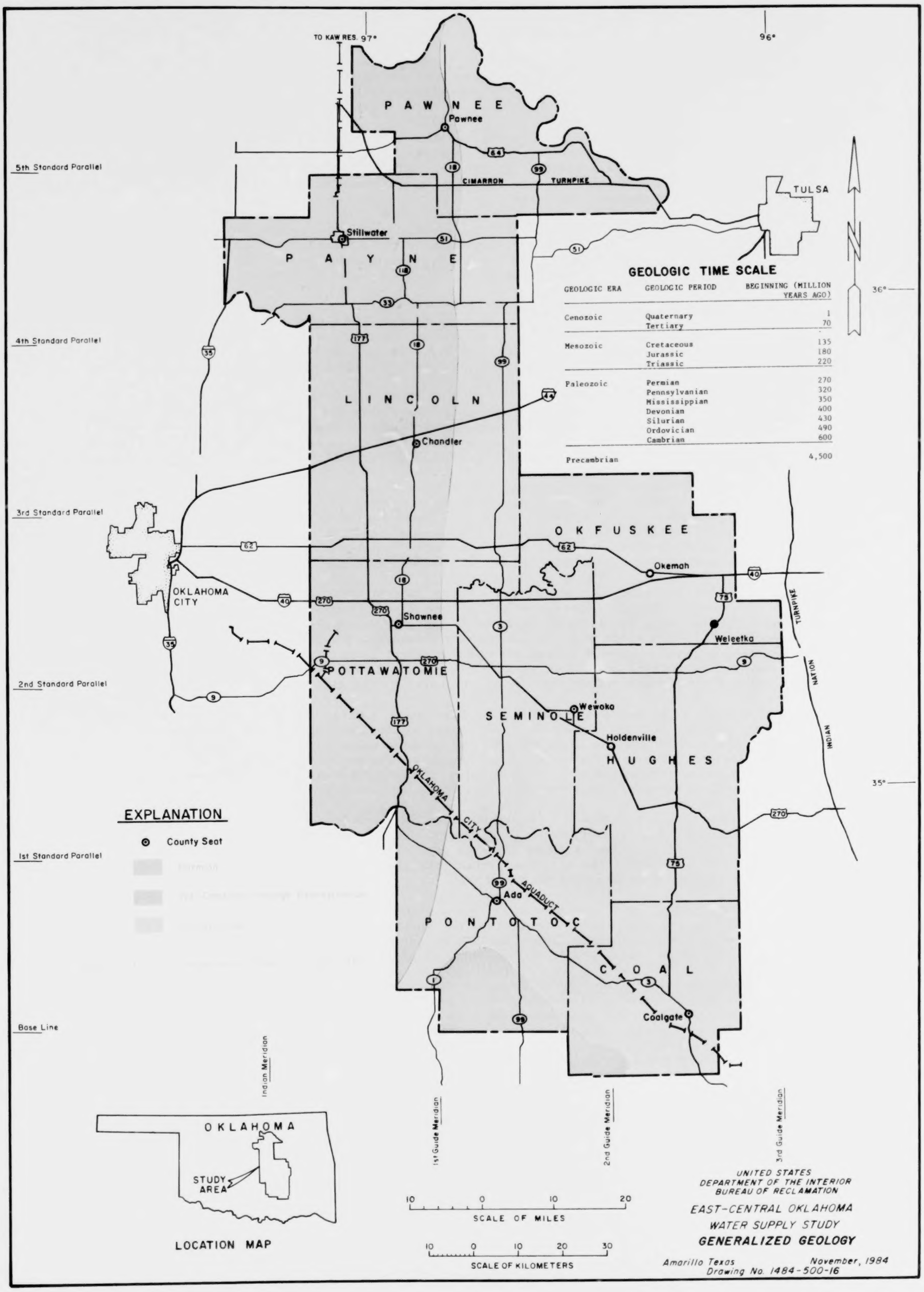
6/ Data from Water Supply Study, Shawnee, Oklahoma, June 1981 by Benham-Blair & Affiliates, Inc.,



The aerial view of the Canadian River, north of Ada, shows the Oklahoma City Aqueduct as it crosses the river. The aqueduct conveys water from Atoka Reservoir to Stanley Draper Lake.



Dense forest nearly obscures the Little River as it flows through lower Seminole County.


TO KAW RES.
97°
96°
36°
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PAWNEE
Pawnee
PAYNE
Stillwater
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5th Standard Parallel
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3rd Standard Parallel
2nd Standard Parallel
1st Standard Parallel
Base Line
Indian Meridian
1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
64
18
99
51
118
33
177
35
44
62
40
270
9
3
75
1
EXPLANATION
County Seat
OKLAHOMA
STUDY AREA
LOCATION MAP
10 0 10 20
SCALE OF MILES
10 0 10 20 30
SCALE OF KILOMETERS

GEOLOGIC TIME SCALE

GEOLOGIC ERA	GEOLOGIC PERIOD	BEGINNING (MILLION YEARS AGO)
Cenozoic	Quaternary	1
	Tertiary	70
Mesozoic	Cretaceous	135
	Jurassic	180
	Triassic	220
Paleozoic	Permian	270
	Pennsylvanian	320
	Mississippian	350
	Devonian	400
	Silurian	430
	Ordovician	490
	Cambrian	600
Precambrian		4,500

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY
GENERALIZED GEOLOGY

Amarillo Texas *November, 1984*
Drawing No. 1484-500-16

Nonmarine shales and sandstones characterize the Mesozoic sedimentary rocks of Oklahoma. Shallow seas covered southern and western Oklahoma during some of the era's Cretaceous period, and marine deposits resulted in limestone and shale.

Since the beginning of the Tertiary period, none of the state has been covered by sea water. Oklahoma's land surface sloped down to the east and southeast, and extensive deposits of Tertiary sand and gravel were washed in by large rivers flowing from the newly formed Rocky Mountains.

The Quaternary period through the present is characterized as a time of erosion. Rocks and loose sediment at the surface are being weathered to soil, then the soil particles are carried away to streams and rivers. In this way, hills and mountains are worn down, and the sediment is either carried to the sea or at least temporarily deposited on the banks and in the bottoms of rivers and lakes.

2. Location and description of aquifers. Principal ground water aquifers in the study area are shown on map No. 1484-500-14. Descriptive information on the aquifers have been taken from the July 1984 draft TVA report entitled Water Supplies of Southeastern Oklahoma. The report covered the 24 Redark counties, which includes the 9 counties in the study area for this report.

a. Quaternary alluvial and terrace aquifer--Alluvial and terrace deposits of sand and gravel to the major streams in southeastern Oklahoma make up one of the most productive aquifers in the study area (Bingham and Bergman 1980). Because of the similarity of the water-bearing properties of the alluvium and terrace deposits, they are combined and referred to as the alluvial and terrace aquifer. These aquifers range in thickness from 50 to 200 feet and range in width from 1 to 5 miles.

The aquifer is connected with the perennial streams in the area and is composed of sand and gravel in the lower part of the alluvium. Ground water generally is at shallow depths within the reach of plant roots. The alluvial material above the sand and gravel varies from fine sand to silt and clay; consequently, the water in the aquifer may be under water table or semiconfined conditions.

Well yields in the alluvial aquifer are largest in those areas where the saturated coarse sand and gravel are thickest. Where the basal coarse sand and gravel zone is thick, the aquifer yields 150 to 500 gallons per minute (gal/min); where the basal coarse sand and gravel zone is thin or absent, well yields are less than 50 gal/min. The alluvial aquifers located along minor streams are composed of fine-grained sand containing varying amounts of silt and clay; thus, the permeability is generally low. Well yields range from less than 25 gal/min to a maximum of 50 gal/min.

Development and use of wells in the alluvial aquifer located along streams can result in a severe reduction or even depletion of streamflow or deterioration in ground water quality. Some of the water pumped from wells in the alluvial aquifers is the same water that would have discharged to the streams, and pumping from wells near the streams may induce water into the aquifer from the affected stream. Inducing recharge from a stream may cause a deterioration of water quality in the alluvial aquifer. During periods of base flow, water in the major streams contains more dissolved minerals and more natural and manmade pollutants than water stored in the adjacent alluvial aquifer.

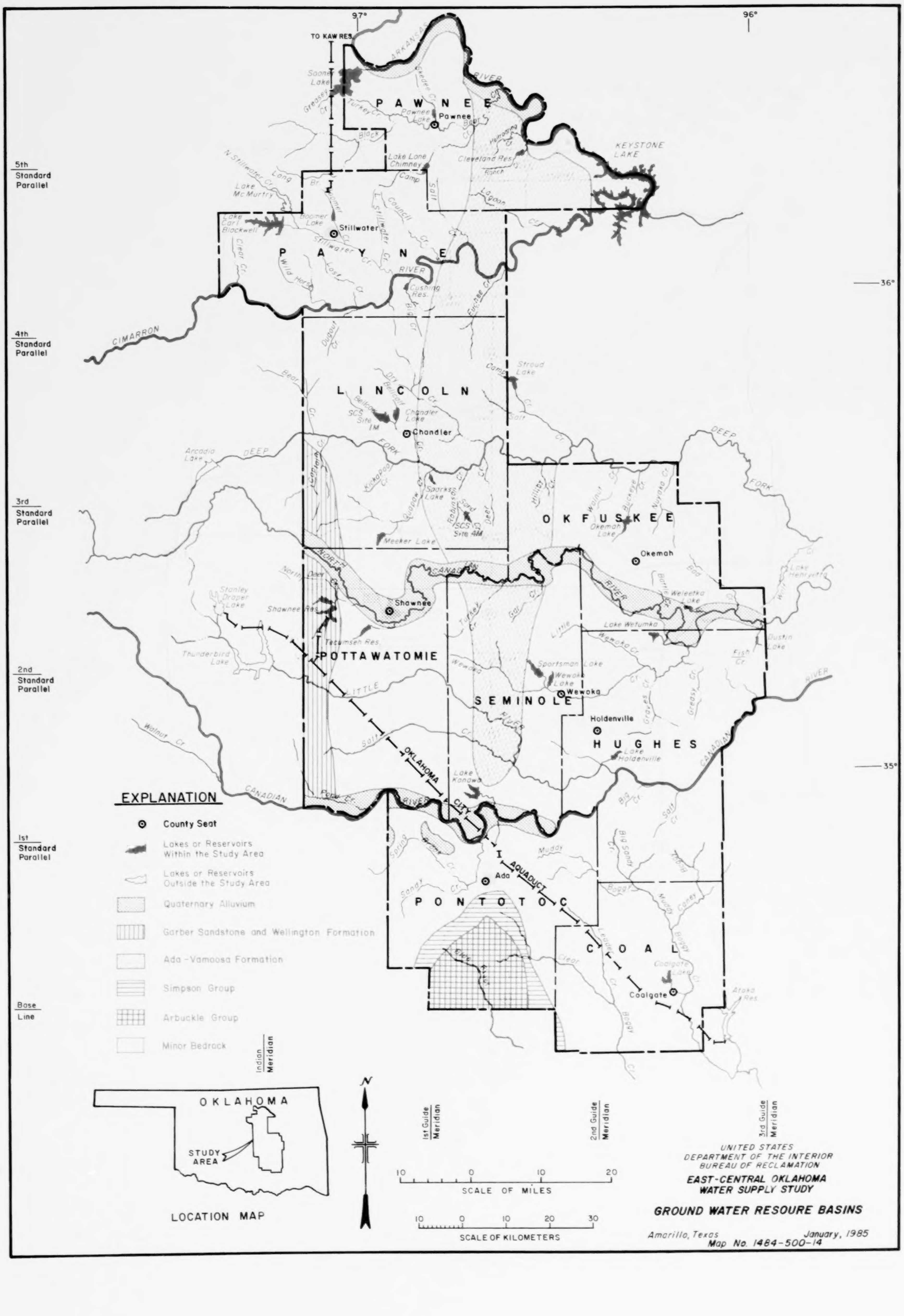
Ground water use by 20 water systems in the Quaternary aquifer in 1982 totaled approximately 2.22 million gallons per day (Mgal/d). The average use per well ranged from about .01 to .03 Mgal/d. The aquifer has the potential use per existing wells to develop about 8.0 Mgal/d as an additional supplemental supply for existing or new water systems in the 24-county study area (TVA study area). The cost effectiveness of developing this alternative future source of water supply should be determined to verify this option.

Analyses indicate that water from the alluvium generally contains less than 1,000 milligrams per liter (mg/L) dissolved solids. The water is of the calcium-magnesium-bicarbonate type. Locally, the alluvium along some of the minor streams contains more than 1,000 mg/L dissolved solids. A large variation in water quality of the alluvium probably is the result of pumpage, which increases the inflow of poor quality water from the nearby stream.

Additional water quality data are needed to characterize the variable quality of water of the alluvial aquifer in the study area. Generally, the quality is suitable for potable supplies with minimal treatment. However, replacement water supplies are needed or specialized treatment is required to reduce brine nitrates and, in some cases, heavy metal contamination problems in some areas.

b. Garber-Wellington Aquifer--The Garber-Wellington Aquifer in western Lincoln and Pottawatomie Counties includes all of the water-bearing units of Permian age in the study area (Bingham and Moore 1975). The aquifer consists of fine- to medium-grained sandstone beds irregularly interbedded with shale. The thickness of individual sandstone beds ranges from a feather edge to as much as 50 feet within short lateral distances. The combined maximum thickness of the formations is more than 500 feet. The transmissibility of the fine-grained sandstone is not high and drawdowns in wells are great, but some wells yield as much as 100 to 200 gal/min.

The sandstone grains of the aquifer are loosely cemented, and ground water occurs in fractures and bedding planes between the sandstone and shale beds. In the outcrop area, ground water is unconfined and occurs under water table conditions. Where the sandstone beds are overlain by shale units, the aquifer is partially confined; but most of the water-bearing beds are hydrologically connected.


97°
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TO KAW RES.
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4th Standard Parallel
3rd Standard Parallel
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1st Standard Parallel
Base Line
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PAYNE
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OKFUSKEE
POTTAWATOMIE
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PONTOTOC
COAL
Pawnee
Stillwater
Chandler
Okemah
Shawnee
Wewoka
Holdenville
Ada
Coalgate
ARKANSAS
RIVER
CIMARRON
RIVER
DEEP FORK
NORTH CANADIAN
RIVER
CANADIAN
RIVER
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Cushing Res.
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Arcadia Lake
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Wewoka Lake
Lake Holdenville
Lake Konawa
Coalgate Lake
Atoka Res.
OKLAHOMA CITY AQUADUCT
EXPLANATION
County Seat
Lakes or Reservoirs Within the Study Area
Lakes or Reservoirs Outside the Study Area
Quaternary Alluvium
Garber Sandstone and Wellington Formation
Ada-Vamoosa Formation
Simpson Group
Arbuckle Group
Minor Bedrock
OKLAHOMA
STUDY AREA
LOCATION MAP
N
10 0 10 20
SCALE OF MILES
10 0 10 20 30
SCALE OF KILOMETERS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY

GROUND WATER RESOURE BASINS

Amarillo, Texas January, 1985
Map No. 1484-500-14

Ground water use by four water systems in the Garber-Wellington Aquifer in 1982 totaled approximately 0.27 Mgal/d. The average use per well ranged from about .07 to .17 Mgal/d. The aquifer has the potential use per existing wells to develop about 0.2 Mgal/d of additional water which could serve as supplemental or sole sources of supply for existing or new water systems in the 24-county study area (TVA study area). The cost effectiveness of developing this alternative future souce of water supply, however, should be determined to verify this option since it would require the construction of six new wells. The development and use of large capacity wells in this aquifer, however, might result in the deterioration of water quality because of the saline water in some sandstone units in the area. Also, large pumping amounts would exceed recharge, resulting in mining of water and a lowering of the water level.

The water quality of the Garber-Wellington is generally good in most of the outcrop area. The water is moderately hard and of the sodium-bicarbonate type. Downdip, the water becomes highly mineralized.

Additional water quality data are needed to characterize the quality of water of the Garber-Wellington.

c. Ada-Vamoosa Aquifer (Pennsylvanian)--The Ada-Vamoosa Aquifer is the major aquifer in Pawnee, Payne, Lincoln, Seminole, and Pontotoc Counties (Bingham and Moore 1975). The aquifer consists of fine- to coarse-grained sandstone beds irregularly interbedded with shale. The thickness of the sandstone beds varies considerably within short lateral distances. The combined maximum thickness of the Ada-Vamoosa Formations is about 600 to 750 feet with a saturated sandstone bed thickness of 150 to 200 feet. Deep wells which penetrate the maximum thickness of saturated sandstone commonly yield 100 to 150 gal/min. Shallow wells which penetrate only some of the sandstone beds generally yield only 25 to 50 gal/min.

The sandstone grains of the aquifer are cemented, and ground water occurs in fractures and bedding planes between the sandstone and shale beds. In most of the area, ground water is unconfined and occurs under water table conditions.

Saltwater from oilfield activities has impacted water in some sandstone units of the Ada-Vamoosa. The location and extent of the aquifer brine contamination has been studied by the U.S. Geological Survey (USGS) and will be discussed later under water quality.

Ground water use by 21 water systems in the Ada-Vamoosa Aquifer totaled approximately 7.2 Mgal/d in 1982. Two-thirds of this use was supplied by the Ada municipal system, which is the largest ground water user in the study area. The average well use ranged from .01 to .07 Mgal/d except for the Ada well system. The aquifer has the potential to develop about 4.4 Mgal/d of additional water, which could serve as supplemental or sole sources of supply for existing or new water systems in the study area. The cost effectiveness of developing this alternative future source of water supply, however, should be determined to verify this option. The development and use of large capacity wells in this aquifer might result in the deterioration of water quality because of the saline water in some sandstone units of the aquifer.

The quality of water from the Ada-Vamoosa Aquifer varies from good to poor. The water is hard or very hard and generally contains less than 500 mg/L dissolved solids. Locally, the water contains sulfate and chloride in excess of 250 mg/L, the maximum recommended for drinking water. Some mineralization of the water might be due to contamination by oil well brines, particularly in the vicinity of the many oilfields. Such contamination may result from seepage from waste pits, defective well casing, defective well abandonment, water flooding operations, or improper brine disposal.

Additional water quality data are needed to characterize the quality of water of the Ada-Vamoosa and to determine the location and extent of brine contamination of the aquifer.

d. Minor bedrock aquifers (Pennsylvanian)--With the exception of the Ada-Vamoosa aquifer, all of the geologic formations of Pennsylvanian age in the study area comprise a minor bedrock aquifer which underlies about three-fourths of the area (Marcher 1969). This aquifer consists of shale, siltstone, coal, limestone, and clay units interbedded with fine- to coarse-grained sandstone.

Ground water occurs under water table conditions in fractures, faults, and bedding planes between the sandstone and shale beds. Ground water yields depend upon the number and interconnection of the openings in the sandstone because the sandstone grains are cemented. Commonly, ground water yields range from a fraction of 1 gal/min to less than 20 gal/min.

Ground water use by 24 water systems in the minor bedrock aquifer totaled approximately 1.5 Mgal/d in 1982. The average well use ranged from .01 to .03 Mgal/d. The aquifer has the potential use per existing wells to develop about 0.8 Mgal/d of additional water which could serve as supplemental or sole sources of supply for existing or new water systems in the 24-county study area (TVA study area). These systems are located generally in the interstream areas where there are problems with inadequate water quantities. The cost effectiveness of developing these potential future supplies may be severely limited because of the low available quantity of ground water. The cost effectiveness of developing these sources should be determined before planning additional wells in the minor bedrock aquifer.

The quality of water from the minor bedrock aquifer generally is good. The water is hard or very hard and generally contains less than 500 mg/L dissolved solids. Some local mineralization of the water might be due to contamination by oil well brines, particularly in the vicinity of the many oilfields. Additional water quality data are needed to characterize the quality of water from the minor bedrock aquifer.

e. Arbuckle-Simpson Aquifer--The Arbuckle-Simpson Aquifer occurs in parts of Pontotoc, Murray, and Johnston Counties (Hart 1974). The aquifer consists of dolomite, limestone, and fine-grained, friable, loosely cemented sandstones. The aquifer is about 300 to 500 feet thick. Yields of 200 to 500 gal/min are common in the outcrop area of the aquifer.

Ground water occurs under water table conditions in fractures and cavities in the carbonate units of the aquifer. Ground water use by four water systems in the aquifer was about 1.5 Mgal/d in 1982. The average use per well ranged from about .01 to .26 Mgal/d. The aquifer has the potential use per existing wells to develop about 1.1 Mgal/d of additional water which could serve as supplemental or sole sources of supply for existing or new water systems in the 24-county study area (TVA study area). The cost effectiveness of developing these potential future supplies, however, should be determined before planning additional wells in this aquifer.

The quality of water from the Arbuckle-Simpson Aquifer is generally good and is usually of the bicarbonate type. The dissolved solids content is generally less than 500 mg/L. Some local mineralization of the water might be due to contamination by oil well brines, particularly in the vicinity of the oil fields.

3. Existing ground water supply capability. Capability in this text is defined as the best estimate of the amount of water that can be produced by the existing in-place well system. The capability values are not referring to the maximum available local ground water production quantities. Very preliminary estimates have been made of the existing ground water supply capabilities of the study area's respective well systems. Sources of information include (1) Water Supplies of Southeastern Oklahoma, draft report, TVA, July 1985; (2) Rural Water Systems in Oklahoma, OWRB, September 1980; (3) staff at SODA; and (4) telephone calls to water user entities. Some entities do not have any data on their well capacities. The TVA noted that a number of entities reported well capacities that were questionable in light of other known data. The number and size of wells seem to be dynamic, with a number of changes within the study area when data of 1 or more years difference are compared. A number of changes have been noted during the few brief months this study has been underway. Water withdrawal rate permits are also shown in table IX-4. They are not based on well-pumping capacity, but rather approval of the amount requested by the water user entity in terms of anticipated needs rather than existing capabilities. Other factors sometimes used in making estimates were average daily use, peak demand, storage capacity, and reported shortage data.

Table IX-4 displays these preliminary estimates of existing ground water supply capability. Estimated total for the study area is about 16.6 Mgal/d, 64 percent of which belongs to the cities of Ada (8.16 Mgal/d) and Seminole (2.38 Mgal/d). It is interesting to note that Pontotoc is the only study area county to depend exclusively on ground water supplies.

C. Water Quality

1. Surface water quality. As in most of the other parts of the State, the quality of surface waters in the study area fluctuates widely. A principal problem hindering surface water development in western and central Oklahoma is water quality. In western Oklahoma and the major river basins flowing into central and eastern Oklahoma, most of the the surface water quality problem is due to natural brine and gypsum contamination from ancient Permian geological salt formations that pollute the surface water supplies.

Reclamation Service began study of these natural brine contamination springs and seeps in the early 1900's. During the 1960's, the U.S. Public Health Service, precursor to the Environmental Protection Agency (EPA), made several excellent reports of the gypsum and brine contamination problems in the region. Later the Corps developed engineering and economic evaluations of possible pollution by the natural brines. The Corps' study plans have not yet been developed beyond experimental or small scale demonstration projects.

The Cimarron River is severely polluted by brine springs, seeps, and salt outcroppings shortly after reentering Oklahoma from Kansas near Buffalo, Oklahoma. The brine salt levels probably render the main stem of Cimarron River unfit for surface water development for municipal purposes (without extensive treatment) through the study area.

High evaporation rates and low flows, causing high salt levels during the summer months, hinder utilization of the North Canadian and Canadian Rivers. On the North Canadian River above, through, and below Oklahoma City, wastewater discharges, especially during base flows, have adversely affected the potential surface water development of this major river. Urban runoff from the Oklahoma City metropolitan area also has adversely affected the surface water quality of the upper Deep Fork, North Canadian, and the upper Little River drainages. Future development of these streams would require water quality analyses prior to municipal water development. As will be noted later, brine contamination from older, unregulated oilfield development also contributed to limiting areas suitable for surface water and ground water development and, in some cases, may preclude cost-effective development of otherwise suitable reservoir sites. An example of oilfield contamination hampering surface water development is what has been noted by Reclamation's study of the Sasakwa reservoir site. Water quality data and consultations with State personnel pointed to brine contamination of Salt Creek and the lower Little River drainage basins. Salt levels are probably sufficient to preclude economic development of Sasakwa damsite through normal reservoir operations and water quality treatment processes.

However, Reclamation is studying the Tate Mountain damsite above the Salt Creek tributary on the Little River that apparently has salt levels much less than in the Sasakwa area. Reclamation is participating with USGS in collecting water data to further define quality for the Tate Mountain damsite area. Another possible alternative damsite on the Little River was proposed by Benham-Blair

Table IX-4

Preliminary Estimates of Existing Ground Water Supply Capability 1/

(East-Central Oklahoma Water Supply Study, January 1985, Revised March 1985)

Water User Entity	Number of Wells	Formation	Reported Capacity (Mgal/d)	State Permitted Daily Withdrawal Rate (Mgal/d)	Estimated Total Existing Capability (Mgal/d)
COAL					
Coalgate PWA	4 wells	Minor Pennsylvanian Sandstone	0.13	0.2	0.130
Lehigh, city of	6 wells	Minor Pennsylvanian Sandstone	0.16	0.03	0.045
Tupelo PWA	8 wells (more under construction)	Minor Pennsylvanian Sandstone	0.04	0.18	0.050
				COAL COUNTY TOTAL	0.225
HUGHES					
Calvin, town of	2 wells	Canadian River Alluvium	0.108	0.72	0.070
RWD No. 2 (Stuart)	3 wells	Minor Pennsylvanian Sandstone	0.11	0.11	0.110
				HUGHES COUNTY TOTAL	0.180
LINCOLN					
Big Creek RWC	7 wells	Ada-Vamoosa	0.372	0.14	0.140
Carney, city of	3 wells	Garber-Wellington	0.09	0.06	0.090
Prague, city of	8 wells	Ada-Vamoosa	0.626	0.49	0.626
Tryon, city of	2 wells	Minor Pennsylvanian Sandstone	Unknown	Unknown	0.026
Wellston, city of	3 wells	Garber-Wellington	0.36	Unknown	0.075
				LINCOLN COUNTY TOTAL	0.957
OKFUSKEE					
RWD No. 1 (Boley)	6 wells	Ada-Vamoosa	0.12	Unknown	0.120
Paden, town of	2 wells	Ada-Vamoosa	0.24	Unknown	0.050
				OKFUSKEE COUNTY TOTAL	0.170
PAWNEE					
Blackburn-Skedee Water, Inc.	2 wells	Ada-Vamoosa	0.10	Unknown	0.102
Hallett PWA	3 wells	Ada-Vamoosa	0.192	1.14	0.192
Jennings, town of	3 wells	Ada-Vamoosa	Unknown	0.070	0.070
RWD No. 1	? wells	Minor Pennsylvanian Sandstone	Unknown	Unknown	0.093
RWD No. 2 (Terlton)	3 wells	Ada-Vamoosa	Unknown	Unknown	0.075
Ralston PWA	3 wells	Arkansas River Alluvium	0.204	0.29	0.290
Westport UAT	4 wells	Minor Pennsylvanian Sandstone	0.03	0.10	0.015
				PAWNEE COUNTY TOTAL	0.837
PAYNE					
Cushing, city of	9 wells	Ada-Vamoosa	0.36	3.18	0.360
Glencoe, town of	6 wells	Minor Pensylvanian Sandstone	0.05	0.14	0.050
Perkins, town of	13 wells	Cimarron River Alluvium	0.36	0.64	0.360
Ripley PWA	5 wells	Cimarron River Alluvium	0.05	0.09	0.050
RWD No. 3	4 wells	Cimarron River Alluvium	0.12	Unknown	0.120
Yale, city of	4 wells	Cimarron River Alluvium	0.60	Unknown	0.600
				PAYNE COUNTY TOTAL	1.540
PONTOTOC					
Ada PWA	Bird's Mill Springs and 3 wells	Ada-Vamoosa	8.16	8.64	8.160
Allen PWA	4 wells	Canadian River Alluvium	0.47	0.72	0.170
Francis, city of	4 wells	Canadian River Alluvium	0.12	0.06	0.115
Roff, town of	2 wells	Arbuckle-Simpson	0.36	1.05	0.118
Stonewall, town of	5 wells	Minor Pennsylvanian Bedrock	0.04	0.45	0.070
				PONTOTOC COUNTY TOTAL	8.633
POTTAWATOMIE					
Asher, city of	2 wells	Canadian River Alluvium	0.07	0.17	0.025
Earlsboro Water, Inc.	3 wells	Ada-Vamoosa	0.18	0.29	0.300
McLoud, city of	4 wells	Garber-Wellington	0.31	0.54	0.306
Maud, city of	4 wells	Ada-Vamoosa	0.144	0.46	0.180
St. Louis Utility Authority	2 wells	Minor Pennsylvanian Bedrock	0.05	0.19	0.020
Tecumseh, city of	5 wells	Minor Pennsylvanian Bedrock	0.54	Unknown	0.170
Wanette, city of	2 wells	Canadian River Alluvium	0.05	0.33	0.050
				POTTAWATOMIE COUNTY TOTAL	1.051
SEMINOLE					
Bowlegs, town of	1 well	Ada-Vamoosa	0.03	Unknown	0.030
Bowlegs-Lima Water District	3 wells	Ada-Vamoosa	0.12	0.06	0.200
Konowa, city of	5 wells	Canadian River Alluvium	Unknown	0.36	0.200
Sasakwa, city of	1 well	Minor Pennsylvanian Bedrock	Unknown	0.02	0.018
Sasakwa RWD of the Seminole Nation	2 wells	Minor Pennsylvanian Bedrock	Unknown	Unknown	0.028
Seminole, city of	16 wells	Ada-Vamoosa	2.38	3.89	2.380
				SEMINOLE COUNTY TOTAL	2.856
				GRAND TOTAL FOR STUDY AREA	16.602

1/ Sources: Water Supplies of Southeastern Oklahoma, Draft Report, TVA, July 1984; Rural Water Systems in Oklahoma, OWRB, September 1980; Staff of SODA; and telephone calls to water user entities.

Note: Estimates of capability made by Reclamation are very preliminary in nature.

and Affiliates, Inc. Their Tecumseh damsite is upstream of Reclamation's Tate Mountain site and is described in their June 1981 Water Supply Study, Shawnee, Oklahoma.

Most of the major rivers--Cimarron, North Canadian, and Canadian--in the east-central area have water quality problems (in the case of the Cimarron River) which hinder normal surface water development for municipal water supply purposes. Marginal water quality of the North Canadian and Canadian Rivers is probably a principal reason these basins have not been developed to their full yield potential. However, there are numerous tributaries of the larger rivers that, with standard water treatment, yield very good quality of water. These tributaries are not being utilized to their full development potential. This investigation and other future water development studies will need to address the water quality of these tributaries on a case-by-case basis, which will require development of additional water quality and flow information.

Although the water quality of the previously mentioned major streams appears to limit development possibilities for drinking water supplies, these rivers may still be considered for other water development purposes such as irrigation, power generating plant cooling water, hydropower generation, navigation, flood control, recreation, as well as fish, wildlife, and environmental enhancement.

2. Standards for drinking water quality. The Federal Safe Drinking Water Act and the attendant Federal and State regulations provide a strong legal basis for protecting public health. All water supply systems which have at least 15 service connections and regularly serve at least 25 individuals are regulated by water quality standards.

The Federal Safe Drinking Water Act established primary and secondary drinking water standards for the Nation's water supplies. These standards are contained in the Oklahoma State Department of Health's "Rules and Regulations Governing Operation of Public Water Supply Systems" as maximum allowable levels and recommended maximum levels. Compliance with the maximum allowable levels (primary standards) is mandatory. Systems which do not comply must establish a plan and schedule for correcting deficiencies and be granted a variance or an exemption. They must also notify system users of their noncompliance. Recommended maximum levels (secondary standards) are not mandatory rejection levels and do not require public notification; however, in applying for permits for new systems or revisions to existing systems, public water supplies must address the feasibility of meeting recommended maximum levels in the preliminary engineering report submitted to the Oklahoma State Department of Health.

The Public Water Supply Monitoring Program is administered by the Environmental Health Services of the Oklahoma State Department of Health under EPA Grant No. F-006204-83-0.

Table IX-5 displays the Oklahoma Standards for drinking water quality that are referred to in subsequent discussions:

Table IX-5
Oklahoma Primary (Allowable) and Secondary (Recommended) Drinking Water Standards
(East-Central Oklahoma Water Supply Study, January 1985)

Maximum Allowable Levels
(Primary Standards)

Constituent	Level
Inorganic chemicals	
Arsenic	50 µg/L
Barium	1,000 µg/L
Cadmium	10 µg/L
Chromium	50 µg/L
Lead	50 µg/L
Mercury	2 µg/L
Nitrate (as nitrogen)	10 mg/L
Selenium	1 µg/L
Silver	50 µg/L
Fluoride	1.6 mg/L
Organic chemicals	
Chlorinated hydrocarbons	
Endrin	0.2 µg/L
Lindane	4 µg/L
Methoxychlor	100 µg/L
Toxaphene	5 µg/L
Chlorophenoxys	
2.4-D	100 µg/L
2.4.5-TP (silvex)	10 µg/L
Total trihalomethanes */	100 µg/L
Chloroform	
Bromoform	
Bromodichloromethane	
Dibromochloromethane	
Turbidity	5 NTU

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*/ Standard applies only to systems serving populations greater than 75,000 and is based upon the average of the most recent four quarters.

Table IX-5 (Continued)

Oklahoma Primary (Allowable) and Secondary (Recommended) Drinking Water Standards

(East-Central Oklahoma Water Supply Study, January 1985)

Recommended Maximum Levels

(Secondary Standards)

Constituent	Level
Chloride	250 mg/L
Color	15 color units
Copper	1,000 µg/L
Corrosivity	noncorrosive
Foaming agents	0.5 mg/L
Hydrogen sulfide	0.05 mg/L
Iron	300 µg/L
Manganese	50 µg/L
Odor	3 threshhold odor number
pH	6.5-8.5 Standard units
Sulfate	250 mg/L
Total dissolved solids	500 mg/L
Zinc	5,000 µg/L

3. Ground water quality. The most commonly used aquifer in the study area is the Ada-Vamoosa Formation. The Ada-Vamoosa and Garber-Wellington Aquifers (where available) and the minor Pennsylvanian sandstone aquifers generally meet water quality criteria and standards. However, it is not uncommon to find localized levels of iron, manganese, and total dissolved solids (TDS) that exceed recommended levels in the above aquifers.

Many of the smaller towns and community well systems utilize alluvial aquifers near their local rivers. These alluvial aquifers experience quality problems that frequently exceed the secondary drinking water criteria for dissolved salts, chlorides, iron, manganese and recommended pH limits and, in some cases, exceed the primary drinking water standards for nitrates, fluoride, and barium. The available data indicate that, although these alluvial aquifers do not exceed maximum contaminant levels of heavy metals, the occurrence of heavy metals in the alluvial formations is higher than the typical ground water aquifers of the study area.

The alluvial aquifers associated with the major rivers probably suffer pollution due to the same reasons that their surface water is degraded, as previously discussed in the surface water quality evaluation.

Table IX-6 is an analysis of data taken from the Oklahoma State Department of Health's Public Water Supply Report 1982 and data listed in the OWRB's Rural Water Systems in Oklahoma, September 1980. Although the data in these publications is thought to be accurate, there were not enough samples taken to evaluate the data on a statistical basis. Not all constituents were sampled for every water system and in the case of total chloroform, only the larger systems were sampled.

The table is a representation of one to five individual samples. If more than one sample was available, all data was used to display the average condition in the table. Only data that exceeded recommended standards or criteria is displayed in the table. Lack of displayed data does not imply that the individual systems do not have any water quality concerns.

Although not an enforceable standard for smaller communities, chloroform levels above 50 mg/L are shown in the table where data was available. Chloroform is a measure of tri-halomethanes in water and are known carcinogens caused by the chlorination of organic compounds primarily found in surface water supplies.

As shown in table IX-6, the wells located in alluvial aquifers of the Cimarron, North Canadian, Canadian, Deep Fork, and Arkansas Rivers all experience some water quality problems.

The towns of Wanette and Konawa have experienced excessive barium levels that should be monitored for potential drinking-water-derived health problems. The town of Perkins and the Eastside Mobile Home Park should monitor their Cimarron River alluvial wells for excessive nitrates in their drinking water. Also, the community of Meadow Ridge should monitor its nitrate levels from the North Canadian River alluvium. Excessive levels of nitrates may cause methemoglobinemia (blue babies) in children and pregnant women.

In the Bowlegs and Maud regions of Seminole County, fluoride levels exceed maximum allowable drinking water levels in the Ada-Vamoosa Aquifer. The Ada-Vamoosa Aquifer also experiences localized brine pollution problems from previous oil industry development (USGS Open-File Report 84-445). Recent newspaper articles have reported current problems Sasakwa has been experiencing with brine contamination of its existing wells and their attempted new wells.

There is a need for communities and rural water systems having water quality problems, especially those whose samples exceed established standards and criteria, to replace their present water supply. Studies should be done to determine if the best solution to the problem is to (a) treat the existing water supply, (b) purchase a new supply from a community or rural water system having available good quality water, or (c) join with a group developing a new source of supply of suitable quality.

Table IX-6
Water Quality of Finished Water Supplies
[Only known potential problem constituents shown]
(East-Central Oklahoma Water Supply Study, January 1985)

Entity With Own Water Supply	Source			Maximum Allowable Levels (Primary Standards)			Recommended Maximum Levels (Secondary Standards)							
		Ground												
	Surface	Number of Wells	Formation	Barium Total (µg/L)	Nitrate-Nitrate Total as N (mg/L)	Flouride Total (mg/L)	Iron Total (µg/L)	Manganese Total (µg/L)	pH (units)	Sulfate Total (mg/L)	Total Dissolved Solids (TDS) (mg/L)	Chloride Total (mg/L)	Sodium Total (mg/L)	Chloroform Total (µg/L)
COAL														
Coalgate PWA	(95%) Coalgate Lake	(5%) 4 wells	Minor Pennsylvanian Sandstone	--	In Compliance	--	--	--	--	--	--	--	--	--
Lehigh, city of	--	6 wells	Minor Pennsylvanian Sandstone	--	In Compliance	--	--	--	--	--	--	--	--	--
Tupelo PWA	(35% Lake Coalgate)	(65%) 8 wells	Minor Pennsylvanian Sandstone	--	In Compliance	--	1,050	580	--	--	--	--		
HUGHES														
Calvin, town of	--	2 wells	Canadian River Alluvium	--	In Compliance	--	--	--	6.4	--	--	--	--	--
Dustin, town of	Dustin Lake	--	--	--	In Compliance	--	442	232	5.9	--	--	--	--	--
Hickory Hills	Hickory Hills Lake	--	--	--	In Compliance	--	455	83	6.2	--	--	--	--	--
Holdenville, city of	Lake Holdenville	--	--	--	In Compliance	--	--	--	--	--	--	--	--	--
RWD No. 2 (Stuart)	--	3 wells	Minor Pennsylvanian Sandstone	--	In Compliance	--	--	--	--	--	--	--	--	--
Wetumka, city of	Lake Wetumka	--	--	--	In Compliance	--	--	--	--	--	--	--	--	--
LINCOLN														
Big Creek RWC	--	7 wells	Ada-Vamoosa	--	In Compliance	--	--	--	--	--	--	--	--	--
Carney, city of	--	3 wells	Garber-Wellington	--	In Compliance	--	--	--	--	--	--	--	--	--
Chandler, city of	Chandler Lake	--	--	--	In Compliance	--	--	--	--	--	--	--	--	--
Meeker, city of	Meeker Lake	--	--	--	In Compliance	--	--	--	--	--	--	--	--	107
Midway Trailer Park	--	? wells	Deep Fork Alluvium	--	In Compliance	--	--	--	--	--	--	--	--	--
Miller Trailer Park	--	? wells	Ada-Vamoosa	--	--	2.3	--	--	--	--	--	--	--	--
Prague, city of	--	8 wells	Ada-Vamoosa	--	In Compliance	--	--	--	--	--	--	--	--	--
RWD No. 1 (Sparks)	Sparks Lake	--	--	--	In Compliance	--	--	--	--	--	--	--	--	--
Sac and Fox	--	? wells	Deep Fork Alluvium	--	In Compliance	--	--	--	--	--	--	--	--	--
Stroud, city of	Stroud Lake	13 wells - abandoned early 80's	Ada-Vamoosa	--	In Compliance	--	--	--	--	--	--	--	--	--
Tryon, city of	--	2 wells	Minor Pennsylvanian Sandstone	--	No Data	--	--	--	--	--	--	--	--	--
Wellston, city of	--	3 wells	Garber-Wellington	--	--	2.1	--	--	8.8	--	1,024	--	313	--
OKFUSKEE														
Boley State School	--	4 wells	North Canadian River Alluvium	--	In Compliance	--	--	--	6.1	--	--	--	--	--
Okemah UA	Okemah Lake	--	--	--	In Compliance	--	--	--	--	--	--	--	--	--
Paden, town of	--	2 wells	Ada-Vamoosa	--	In Compliance	--	--	--	--	--	--	--	--	--
RWD No. 1 (Boley)	--	6 wells	Ada-Vamoosa	--	In Compliance	--	--	--	--	--	--	--	--	--
Weleetka, town of	Weleetka Lake	--	--	--	In Compliance	--	--	50	--	--	--	--	--	99
PAWNEE														
Ballerina-Edgewater MHP	--	? wells	Arkansas River Alluvium	--	In Compliance	--	--	--	--	--	--	--	--	--
Blackburn-Skedee Water, Inc.	--	2 wells	Arkansas River Alluvium	--	In Compliance	--	470	935	--	--	609	--	--	--
Cleveland, city of	Cleveland Reservoir	--	--	--	In Compliance	--	--	--	--	--	--	--	--	130
Hallett, town of	--	3 wells	Ada-Vamoosa	--	In Compliance	--	1,935	--	--	--	--	--	--	--
Hill and Dale	--	4 wells	Unknown	--	In Compliance	--	--	--	--	--	599	--	--	--
Jennings, town of	--	3 wells	Ada-Vamoosa	--	In Compliance	--	--	--	--	--	567	--	--	--
Pawnee, city of	Pawnee Lake	--	--	--	In Compliance	--	--	--	--	--	--	--	--	--
RWD No. 1	--	? wells	Minor Pennsylvanian Sandstone	--	In Compliance	--	350	340	--	--	--	--	--	--
RWD No. 2 (Terlton)	(70% city of Cleveland)	(30%) 3 wells	Ada-Vamoosa	--	In Compliance	--	1,810	580	--	--	--	--	--	--
Ralston PWA	--	3 wells	Arkansas River Alluvium	--	In Compliance	--	--	--	--	--	550	--	--	--
Westport UAT	--	4 wells	Minor Pennsylvanian Sandstone	--	In Compliance	--	--	--	--	--	--	--	--	--

Table IX-6 (Continued)
Water Quality of Finished Water Supplies
[Only known potential problem constituents shown]
(East-Central Oklahoma Water Supply Study, January 1985)

Entity With Own Water Supply	Source			Maximum Allowable Levels (Primary Standards)			Recommended Maximum Levels (Secondary Standards)							
		Ground												
	Surface	Number of Wells	Formation	Barium Total (µg/L)	Nitrate-Nitrate Total as N (mg/L)	Flouride Total (mg/L)	Iron Total (µg/L)	Manganese Total (µg/L)	pH (units)	Sulfate Total (mg/L)	Total Dissolved Solids (TDS) (mg/L)	Chloride Total (mg/L)	Sodium Total (mg/L)	Chloroform Total (µg/L)
PAYNE														
Country Club Heights	--	1 well	Ada-Vamoosa	--	In Compliance	--	460	90	--	--	--	--	--	--
Cushing, city of	(90%) Cushing Lake	(10%) 9 wells	Ada-Vamoosa	--	In Compliance	--	--	--	--	--	--	--	--	51
Eastside MHP	--	1 well	Cimarron River Alluvium	--	10.4	--	--	--	--	--	--	--	--	--
Glencoe, town of	--	6 wells	Minor Pennsylvanian Sandstone	--	In Compliance	--	--	--	--	--	517	--	--	--
Perkins, town of	--	13 wells	Cimarron River Alluvium	--	10.1	--	--	--	--	--	--	--	--	--
Ripley PWA	--	5 wells	Cimarron River Alluvium	--	In Compliance	--	--	285	--	--	568	--	--	--
RWD No. 3	--	4 wells	Cimarron River Alluvium	--	In Compliance	--	--	--	--	--	--	--	--	--
Southern Oaks	--	2 wells	Stillwater Creek Alluvium	--	In Compliance	--	--	--	--	--	--	--	--	--
Stillwater, city of	Lakes Carl Blackwell and McMurtry	--	--	--	In Compliance	--	--	--	--	--	--	--	--	--
Twin Hills	--	2 wells	Cimarron River Alluvium	--	In Compliance	--	305	--	--	304	966	--	--	--
Yale, city of	--	4 wells	Cimarron River Alluvium	--	In Compliance	--	--	--	--	--	1,377	556	--	--
PONTOTOC														
Ada, city of	--	Bird's Mill Springs and 3 wells	Ada-Vamoosa	--	In Compliance	--	--	--	--	--	--	--	--	--
Allen PWA	--	4 wells	Canadian River Alluvium	--	In Compliance	--	--	--	6.4	--	--	--	--	--
Francis, city of	--	4 wells	Canadian River Alluvium	--	In Compliance	--	--	--	9.0	--	842	--	--	--
Roff, town of	--	2 wells	Arbuckle-Simpson	--	In Compliance	--	350	--	--	--	--	--	--	--
Stonewall, town of	--	5 wells	Minor Pennsylvanian Bedrock	--	In Compliance	--	300	--	--	--	--	--	--	-
POTTAWATOMIE														
Asher, city of	--	2 wells	Canadian River Alluvium	--	In Compliance	--	--	--	--	--	--	--	--	--
Country Estates MHP	--	1 well	North Canadian River Alluvium	--	In Compliance	--	--	--	--	--	--	--	--	--
Earlsboro Water, Inc.	--	3 wells	Ada-Vamoosa	--	In Compliance	--	--	--	--	--	--	--	--	--
McLoud, city of	--	4 wells	Garber-Wellington	--	In Compliance	--	--	--	--	--	--	--	--	--
Meadow Ridge	--	1 well	North Canadian River Alluvium	--	23.6	--	--	--	--	--	506	--	--	--
Rainbow Valley	--	2 wells	North Canadian River Alluvium	--	In Compliance	--	--	--	--	--	--	--	--	--
Shady Valley	--	3 wells	North Canadian River Alluvium	--	In Compliance	--	--	--	5.9	--	--	--	--	--
Shawnee, city of	Shawnee Reservoir	--	--	--	In Compliance	--	--	--	--	--	--	--	--	--
St. Louis, city of	--	2 wells	Minor Pennsylvanian Bedrock	--	In Compliance	--	--	2,220	--	--	1,146	298	--	--
Tecumseh, city of	(73%) Tecumseh Res.	(27%) 5 wells	Minor Pennsylvanian Bedrock	--	In Compliance	--	--	--	--	--	--	--	--	--
Town and Country MHP	--	2 wells	North Canadian River Alluvium	--	In Compliance	--	--	--	--	--	--	--	--	--
Wanette, city of	--	2 wells	Canadian River Alluvium	1,250	—	--	--	345	--	--	612	--	--	--
SEMINOLE														
Bowlegs, town of	--	1 well	Ada-Vamoosa	--	--	4.6	--	--	8.4	--	917	—	--	—
Bowlegs-Lima Water District	--	3 wells	Ada-Vamoosa	--	--	2.8	--	--	8.8	--	720	—	--	—
Konawa, city of	--	5 wells	Canadian River Alluvium	912*	--	2.5	--	--	--	--	1,080	373	--	--
Lakeside Addition	--	1 well	Canadian River Alluvium	--	In Compliance	--	2,300	280	--	--	--	--	--	--
Lakeview MHP	--	2 wells	Ada-Vamoosa	--	In Compliance	--	--	170	--	--	--	--	--	--
Maud, city of	--	4 wells	Ada-Vamoosa	--	--	4.1	--	--	8.8	--	1,098	--	--	--
Peels MHP	--	2 wells	Ada-Vamoosa	--	--	1.7	--	--	--	--	682	--	--	--
Sasakwa, city of	--	1 well	Minor Pennsylvanian Bedrock	--	In Compliance	--	--	120	--	--	--	--	--	--
Sasakwa RWD of the Seminole Nation	--	2 wells	Minor Pennsylvanian Bedrock	--	In Compliance	--	--	150	--	--	--	--	--	--
Seminole, city of	--	16 wells	Ada-Vamoosa	--	In Compliance	--	--	--	--	--	--	--	--	--
Wewoka, city of	Wewoka Lake	--	--	--	In Compliance	--	--	--	--	--	--	--	--	57

---

* One sample in 1981 exceeded drinking water standard (1,323 ug/L).

4. Brine-water degradation of surface and ground water. The USGS and the Oklahoma Geological Survey are in the process of publishing Open-File Report 84-445. This is an excellent study entitled "Effects of Brine on the Chemical Quality of Water in Parts of Creek, Lincoln, Okfuskee, Payne, Pottawatomie, and Seminole Counties, Oklahoma."

The study indicates that 63 of 168 surface water sites and 20 of 180 ground water sites investigated were degraded by oilfield brines, mostly in the Ada-Vamoosa Aquifer area. The two most reliable indicators of brine contamination were found to be chloride equal to or greater than 400 mg/L and bromide equal to or greater than 2 mg/L. Map No. 1484-500-15 shows the areas determined by Reclamation's evaluation of the report to have been degraded by brine.

The study also refers to a D'Lugosz and McClaflin (1981) report that demonstrated mineralized water entering the upstream reach of Wewoka Creek during August of 1975.

Preliminary examination of the brine-degraded areas illustrates that the Oxbow damsite (Wetumka) on Wewoka Creek and the Paden, Welty, and Tuskegee damsites in the Deep Fork River Basin could have possible problems with higher than expected dissolved salt levels.

Future water development projects in the study area should avoid the noted surface and ground water brine-degraded areas. There is a need to evaluate the remaining parts of the study area not included in the USGS study so that there is a complete picture of brine-water degradation problems.

Clear Boggy Creek and tributary in Coal County are typical of tributary streams having good quality flows.

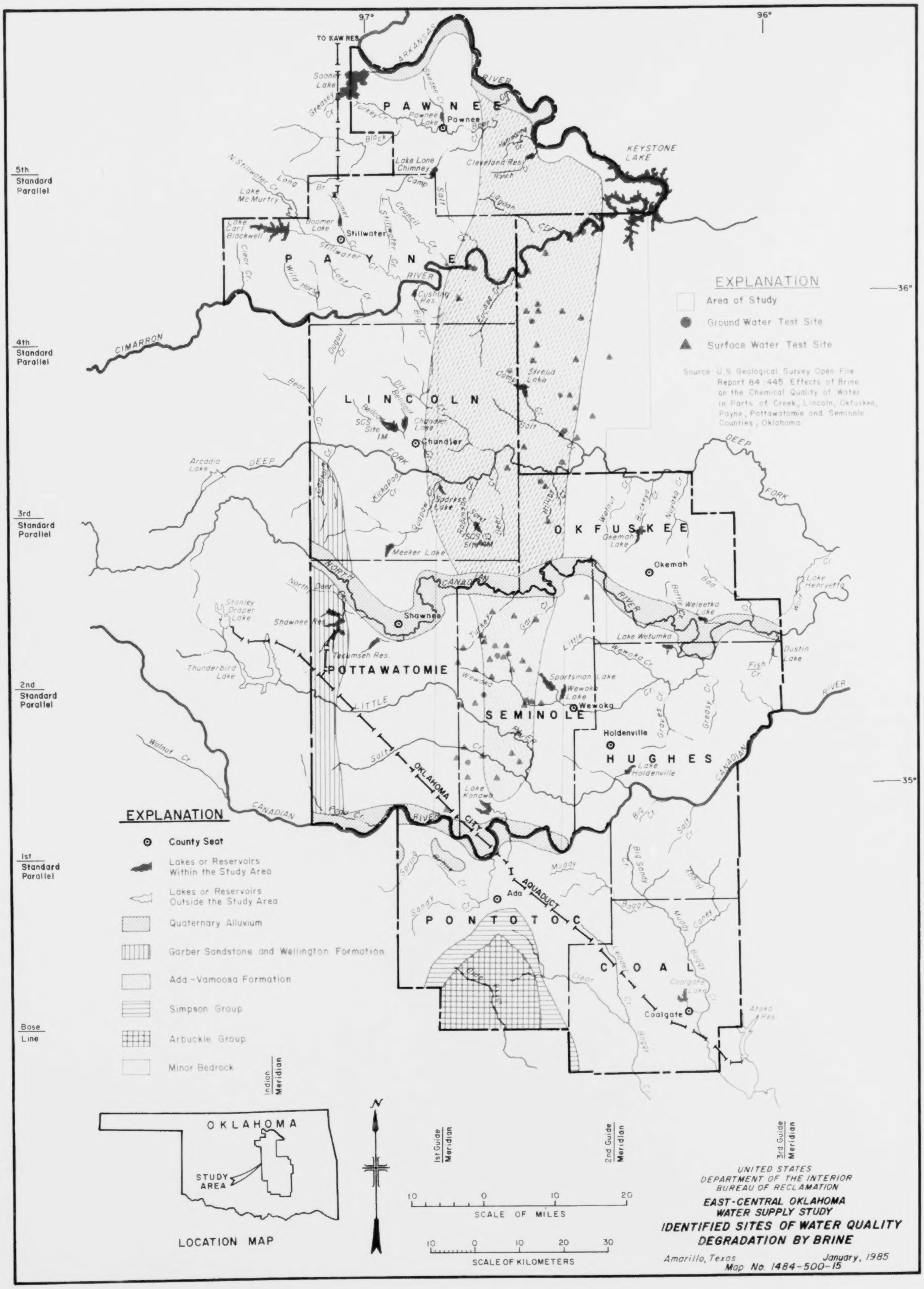
The major rivers in the study area have problems with water quality degradation. from natural and manmade sources. Here, oil wells are shown located in the bed of a river.

D. M&I Demands

1. Municipal-rural water user entity problems. In mid-1984, TVA completed a 2-year study of short-term (up to year 1990) water system problems that included all of the study area. The study included an analysis of delivery system problems as well as the more traditional type of water supply study. Delivery system problems analyzed included an inadequate water treatment plant capacity, insufficient storage capacity, undersized mains and lines (pressure loss), problems with leaks, and age deterioration. These factors can contribute to a system's inability to deliver enough water during peak demand periods as much as an inadequate water supply. In their report (appendix C) 1/, TVA tabulated water system entity problems which indicated that this 9-county study area contained 92 water user entities (municipal and rural systems) of which 60 were sources of their own water supplies, with the remaining 32 purchasing water supplies from source entities. The TVA data indicated that 22 percent of the 60 source entities had water treatment plants having capacities too small to handle peak demands. Of the 92 water user entities, 32 percent had insufficient storage, 35 percent had serious problems with leaks, 17 percent had serious loss of pressure due to water mains and water lines being undersized for the number of customers being served, and 22 percent reported that their entire system needed to be replaced due to age deterioration. In addition, the TVA data included information on reported water shortages and known water quality problems for the 60 water supply source entities which indicated that 50 percent had reported seasonal (one reported frequent) water shortages; 35 percent were listed as having one or more water quality constituents that exceeded standards; and 37 percent were listed as being vulnerable to potential contamination by agricultural, energy, and mining activity as well as being unprotected (legislatively) from inadequate waste disposal, according to State health department evaluations. Table IX-7 displays the TVA data for the study area.

Similar but somewhat less detailed information was included on a county-by-county basis in OWRB's January 1982 report entitled Report to Governor George Nigh On Community Water Problems and Funding Needs. One advantage of the OWRB report was that it contained cost estimates which are critical to the decisionmakers and political leaders who must attempt to find funds needed to alleviate all the problems. A mechanism needs to be found whereby one agency has the responsibility and resources (both human and fiscal) to keep this sort of information on a continuous, up-to-date basis.

1/ Water Supplies of Southeastern Oklahoma, draft report, TVA, July 1984.


97°
96°
TO KAW RES.
36°
35°
5th Standard Parallel
4th Standard Parallel
3rd Standard Parallel
2nd Standard Parallel
1st Standard Parallel
Base Line
Indian Meridian
1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
PAWNEE
PAYNE
LINCOLN
OKFUSKEE
POTTAWATOMIE
SEMINOLE
HUGHES
PONTOTOC
COAL
Pawnee
Stillwater
Chandler
Okemah
Shawnee
Wewoka
Holdenville
Ada
Coalgate
ARKANSAS RIVER
CIMARRON RIVER
DEEP FORK
NORTH CANADIAN RIVER
LITTLE RIVER
CANADIAN RIVER
KEYSTONE LAKE
Sooner Lake
Pawnee Lake
Lake Lone Chimney
Cleveland Res.
Lake McMurtry
Lake Carl Blackwell
Boomer Lake
Cushing Res.
Stroud Lake
Chandler Lake
Bellcow SCS Site 1M
Arcadia Lake
Sparks Lake
SCS Site 2M
Meeker Lake
Okemah Lake
Lake Henryetta
Weleetka Lake
Lake Wetumka
Dustin Lake
Stanley Draper Lake
Shawnee Res.
Tecumseh Res.
Thunderbird Lake
Sportsman Lake
Wewoka Lake
Lake Holdenville
Lake Konawa
Coalgate Lake
Atoka Res.
OKLAHOMA CITY AQUADUCT
EXPLANATION
Area of Study
● Ground Water Test Site
▲ Surface Water Test Site
EXPLANATION
⊙ County Seat
Lakes or Reservoirs Within the Study Area
Lakes or Reservoirs Outside the Study Area
Quaternary Alluvium
Garber Sandstone and Wellington Formation
Ada-Vamoosa Formation
Simpson Group
Arbuckle Group
Minor Bedrock
OKLAHOMA
STUDY AREA
LOCATION MAP
N
SCALE OF MILES 10 0 10 20
SCALE OF KILOMETERS 10 0 10 20 30

Source: U.S. Geological Survey Open File Report 84-445, Effects of Brine on the Chemical Quality of Water in Parts of Creek, Lincoln, Okfuskee, Payne, Pottawatomie and Seminole Counties, Oklahoma

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EAST-CENTRAL OKLAHOMA WATER SUPPLY STUDY

IDENTIFIED SITES OF WATER QUALITY DEGRADATION BY BRINE

Amarillo, Texas January, 1985
Map No. 1484-500-15

Table IX-7
Municipal-Rural Water Entity Problems Listed by TVA 1/
(East-Central Oklahoma Water Supply Study, January 1985)

County	Water Shortages		Quality Problems		Distribution System Problems				
	Frequent (sources)	Seasonal (sources)	Quality Exceeds Standards (entities)	Potential for Contamination 2/	Problem with Leaks (systems)	Pressure Loss - Small Lines (systems)	Age Deterioration (systems)	Insufficient Storage (systems)	Inadequate Treatment Plant Capacity (systems)
Coal 3 sources (6 entities)	-0-	3 (6 total)	3 (1 with multiple problems)	-0-	2	2	-0-	3	2
Hughes 7 sources (10 entities)	-0-	4 (6 total)	-0-	1 UW	1	1	2	2	2
Lincoln 9 sources (11 entities)	-0-	7 (8 total)	2 (1 with multiple problems)	-0-	5	4	3	4	2
Okfuskee 4 sources (6 entities)	-0-	2 (4 total)	-0-	-0-	1	2	2	1	1
Pawnee 10 sources (14 entities)	-0-	3 (4 total)	5 (3 with multiple problems)	-0-	5	1	3	1	1
Payne 7 sources (11 entities)	1	-0-	4 (2 with multiple problems)	5-AA	3	3	3	6	2
Pontotoc 5 sources (13 entities)	-0-	2	1	-0-	6	1	1	2	0
Pottawatomie 8 sources (9 entities)	-0-	4	1	4 AA 4 EM 2 UW	6	1	4	5	2
Seminole 7 sources (12 entities)	-0-	4 (7 total)	5 (4 with multiple problems)	6 EM	3	1	2	5	1
Study Area Totals 60 sources (92 entities)	1	29 (41 total)	21 (11 with multiple problems)	9-AA 10-EM 3-UW	32	16	20	29	13

1/ Source: 1984 TVA Draft Report: Water Supplies of Southeastern Oklahoma.

2/ Potential contamination evaluations by State Health Department:
AA = Agricultural activity contamination.
EM = Energy and mining activity wastes.
UW = Unprotected (legislatively) from inadequate waste disposal.

2. Existing water supplies, current M&I use, and present shortages. Table IX-2 presented estimates of firm yields of existing surface water (reservoir) supplies. Table IX-4 presented preliminary estimates of existing ground water (well) capability. This information has been combined with data from the TVA study into a single table displaying all the more critical factors affecting water user entities experiencing water shortages to customers.

Before the table and a summary analysis are presented, several important concepts will be reviewed to assure proper interpretation of the table and understanding of the analysis text.

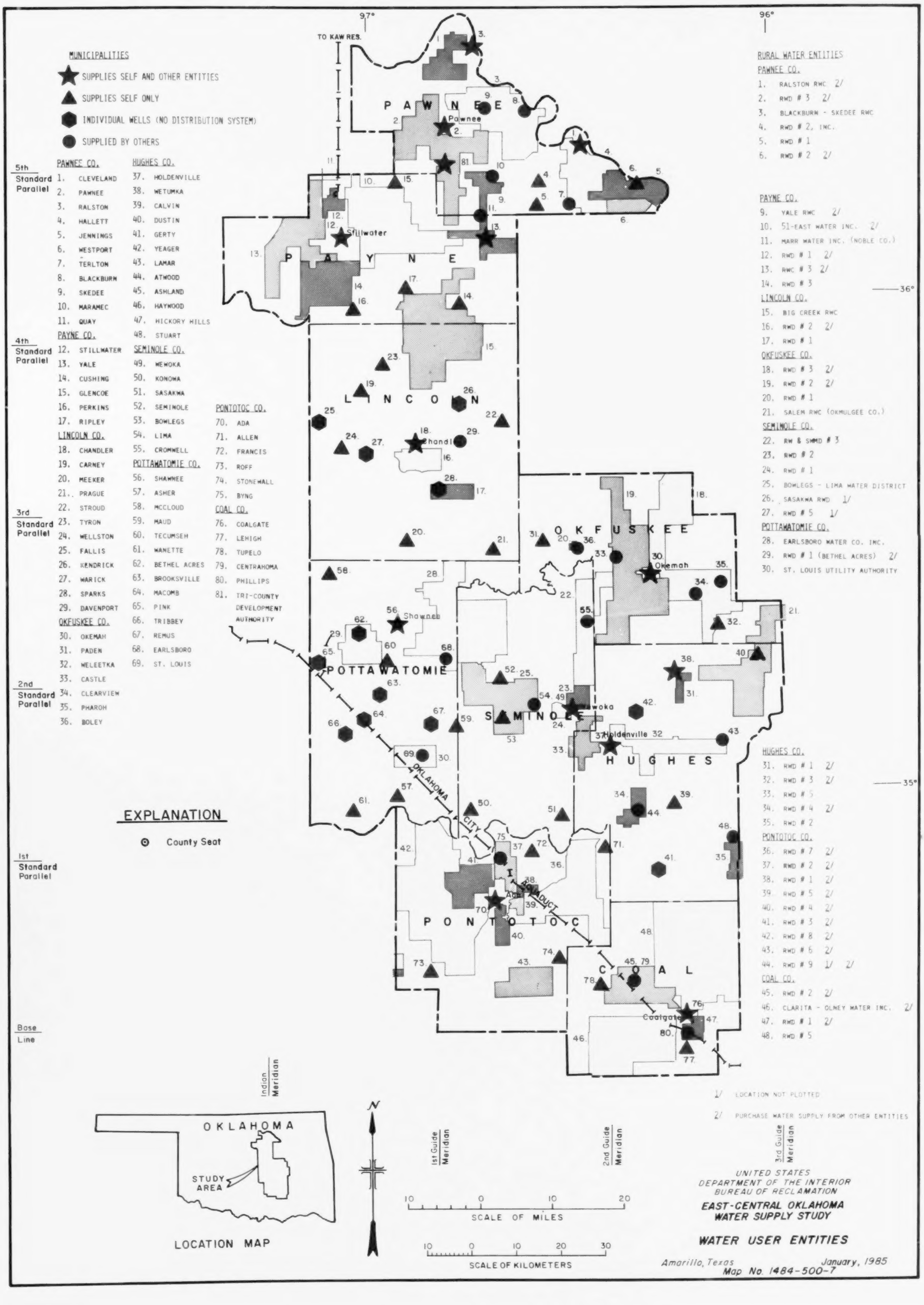
a. Firm or dependable yield--Most people have observed ponds, lakes, or reservoirs whose water levels have dropped dramatically or completely dried up during periods of drought. Water resource development planners have to plan reservoirs that will dependably deliver the required amount of water even during the worst of long droughts such as central Oklahoma experienced during the early and middle 1950's. This is accomplished by adding what is called carryover storage to the storage required for a normal year. Carryover storage is the amount of water needed to meet supply requirements for a period equal to the longest drought for which there are records. There are firm yield surface water supplies listed in the table that are smaller than the peak demands or even the average daily use being consumed. This indicates that carryover storage is being used to meet demands during nondrought periods. The result of this type of operational procedures will be a less than full reservoir when the drought begins (insufficient carryover storage), and reservoir yield will be less than the firm yield. This concept can also be applied to ground water. The aquifers are similar to giant underground reservoirs. When precipitation stops, there is no water percolating down into the aquifer from the surface to recharge the supply, and the water table in the aquifer drops, slowly diminishing the amount of water a well is able to pump to the surface.

b. Water treatment plant capacity--This amount has to be an amount equal to or preferably greater than peak demands. A treatment plant incapable of delivering a sustained peak demand during a 10-day hot, dry spell will result in shortages at a time when the water is most needed.

c. Storage capacity--Requirements for storage capacity in standpipes, temporary storage reservoirs, and towers can vary between systems; however, TVA mentioned a factor of 1-1/2 times the peak demand. Extra storage to handle such things as firefighting or downtime for maintenance or emergency repairs of the waterworks are easy to understand. The extra storage required for peak demands is more complicated. A system that has peak demands of 0.240 Mgal/d and water treatment plant capacity of 0.240 Mgal/d may appear to have just enough capacity; however, this is not the case. The water treatment plant is capable of producing 0.010 million gallons per hour (Mgal/h) for each of the 24 hours. The peak demand does not work that way because it is caused by human activity, resulting in little demand during the night, and may be as high as 0.030 or 0.040 Mgal/h during the late afternoon and early evening, which would exceed the treatment plant capacity.

Standpipes (on the left) and elevated tanks are the most common water storage structures.

Table IX-8 displays the existing water supplies, presents M&I use, and associated information discussed above. Because it presents detailed information for each of the nine counties in the study area, it covers four pages (sheets 1 to 4). Map No. 1484-500-7 displays most of the water user entities listed in table IX-8. A county-by-county analysis of short-term water supplies is provided in the following paragraphs.


MUNICIPALITIES
★ SUPPLIES SELF AND OTHER ENTITIES
▲ SUPPLIES SELF ONLY
⬢ INDIVIDUAL WELLS (NO DISTRIBUTION SYSTEM)
● SUPPLIED BY OTHERS
PAWNEE CO.
1. CLEVELAND
2. PAWNEE
3. RALSTON
4. HALLETT
5. JENNINGS
6. WESTPORT
7. TERLTON
8. BLACKBURN
9. SKEDEE
10. MARAMEC
11. QUAY
PAYNE CO.
12. STILLWATER
13. YALE
14. CUSHING
15. GLENCOE
16. PERKINS
17. RIPLEY
LINCOLN CO.
18. CHANDLER
19. CARNEY
20. MEEKER
21. PRAGUE
22. STROUD
23. TYRON
24. WELLSTON
25. FALLIS
26. KENDRICK
27. WARICK
28. SPARKS
29. DAVENPORT
OKFUSKEE CO.
30. OKEMAH
31. PADEN
32. WELEETKA
33. CASTLE
34. CLEARVIEW
35. PHAROH
36. BOLEY
HUGHES CO.
37. HOLDENVILLE
38. WETUMKA
39. CALVIN
40. DUSTIN
41. GERTY
42. YEAGER
43. LAMAR
44. ATWOOD
45. ASHLAND
46. HAYWOOD
47. HICKORY HILLS
48. STUART
SEMINOLE CO.
49. WEWOKA
50. KONOWA
51. SASAKWA
52. SEMINOLE
53. BOWLEGS
54. LIMA
55. CROMWELL
POTTAWATOMIE CO.
56. SHAWNEE
57. ASHER
58. MCCLOUD
59. MAUD
60. TECUMSEH
61. WANETTE
62. BETHEL ACRES
63. BROOKSVILLE
64. MACOMB
65. PINK
66. TRIBBEY
67. REMUS
68. EARLSBORO
69. ST. LOUIS
PONTOTOC CO.
70. ADA
71. ALLEN
72. FRANCIS
73. ROFF
74. STONEWALL
75. BYNG
COAL CO.
76. COALGATE
77. LEHIGH
78. TUPELO
79. CENTRAHOMA
80. PHILLIPS
81. TRI-COUNTY DEVELOPMENT AUTHORITY
RURAL WATER ENTITIES
PAWNEE CO.
1. RALSTON RWC 2/
2. RWD # 3 2/
3. BLACKBURN - SKEDEE RWC
4. RWD # 2, INC.
5. RWD # 1
6. RWD # 2 2/
PAYNE CO.
9. YALE RWC 2/
10. 51-EAST WATER INC. 2/
11. MARR WATER INC. (NOBLE CO.)
12. RWD # 1 2/
13. RWC # 3 2/
14. RWD # 3
LINCOLN CO.
15. BIG CREEK RWC
16. RWD # 2 2/
17. RWD # 1
OKFUSKEE CO.
18. RWD # 3 2/
19. RWD # 2 2/
20. RWD # 1
21. SALEM RWC (OKMULGEE CO.)
SEMINOLE CO.
22. RW & SWMD # 3
23. RWD # 2
24. RWD # 1
25. BOWLEGS - LIMA WATER DISTRICT
26. SASAKWA RWD 1/
27. RWD # 5 1/
POTTAWATOMIE CO.
28. EARLSBORO WATER CO. INC.
29. RWD # 1 (BETHEL ACRES) 2/
30. ST. LOUIS UTILITY AUTHORITY
HUGHES CO.
31. RWD # 1 2/
32. RWD # 3 2/
33. RWD # 5
34. RWD # 4 2/
35. RWD # 2
PONTOTOC CO.
36. RWD # 7 2/
37. RWD # 2 2/
38. RWD # 1 2/
39. RWD # 5 2/
40. RWD # 4 2/
41. RWD # 3 2/
42. RWD # 8 2/
43. RWD # 6 2/
44. RWD # 9 1/ 2/
COAL CO.
45. RWD # 2 2/
46. CLARITA - OLNEY WATER INC. 2/
47. RWD # 1 2/
48. RWD # 5
1/ LOCATION NOT PLOTTED
2/ PURCHASE WATER SUPPLY FROM OTHER ENTITIES
97°
96°
36°
35°
TO KAW RES.
5th Standard Parallel
4th Standard Parallel
3rd Standard Parallel
2nd Standard Parallel
1st Standard Parallel
Base Line
Indian Meridian
1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
PAWNEE
PAYNE
LINCOLN
OKFUSKEE
POTTAWATOMIE
SEMINOLE
HUGHES
PONTOTOC
COAL
Pawnee
Stillwater
Chandler
Okemah
Shawnee
Wewoka
Holdenville
Ada
Coalgate
OKLAHOMA CITY AQUEDUCT
EXPLANATION
⊙ County Seat
OKLAHOMA
STUDY AREA
LOCATION MAP
N
10 0 10 20
SCALE OF MILES
10 0 10 20 30
SCALE OF KILOMETERS
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY
WATER USER ENTITIES
Amarillo, Texas January, 1985
Map No. 1484-500-7

(Sheet 1 of 4)

Table IX-8
Existing Water Supplies and Present M&I Use 1/
(East-Central Oklahoma Water Supply Study, January 1985)

Water User Entity	Source of Water Supply	Population Served	Estimated Yield of Existing Water Supplies		Average Daily Use (Mgal/d)	Peak Demands (Mgal/d)	Gallons Per Capita Per Day	Treatment Plant Capacity (Mgal/d)	Storage Capacity (Mgal)
			Surface (Mgal/d)	Ground Water (Mgal/d)					
COAL									
Coalgate PWA	(95%) Coalgate Lake (5%) wells	4,066	1.785	--	0.430	0.500	106	0.432 2/	0.280
Clarita-Olney Water Company, Inc.	City of Coalgate	(600)	--	--	(0.055)	--	92	--	0.097
C.C. RWD No. 1 (Phillips)	City of Coalgate	(750)	--	--	(0.048)	--	64	--	None
C.C. RWD No. 2 (Centrahoma)	City of Coalgate	(550)	--	--	(0.030)	--	55	--	0.195
Lehigh, city of	Wells	350	--	0.045	0.045	0.050	128	0.060	0.195
Tupelo PWA	(35%) City of Coalgate (65%) wells	357	--	0.050	0.032	0.035	84	--	0.060
HUGHES									
Allen, town of	(reported under Pontotoc County)								
Calvin, town of	Wells	349	--	0.070	0.067	0.087	192	None	0.250
Dustin PWW	Dustin Lake	496	0.134	--	0.013	0.015	26	0.0072	0.120
Holdenville, city of	Lake Holdenville	4,490	2.053	--	0.900	1.000	200	1.000	2.060
H.C. RWD No. 1	City of Wetumka	(825)	--	--	(0.030)	(0.035)	36	--	0.150
H.C. RWD No. 2 (Stuart) 3/	Wells	700	0.110	--	0.030	0.035	43	None	0.251
H.C. RWD No. 3 (Lamar)	City of Holdenville	(490)	--	--	(0.046)	(0.075)	94	--	1.200
H.C. RWD No. 4 (Atwood)	City of Holdenville	(500)	--	--	(0.055)	--	110	--	0.062
Salem RWC (Okmulgee County) 4/	City of Henryetta	(150)	--	--	(0.020)	--	133	--	0.170
Wetumka, city of	Lake Wetumka	3,825	0.714	--	0.311	0.500	81	0.750	0.575
LINCOLN									
Big Creek RWC 5/	Wells	2,100	--	0.143	0.142	0.165	68	--	0.185
Carney, city of	Wells	800	--	0.090	0.070	0.130	88	--	0.100
Chandler, city of	Chandler Lake	5,500	0.473	--	0.634	0.990	115	1.250	0.340
Davenport, city of	City of Chandler	(900)	--	--	(0.040)	(0.142)	57	--	0.200
L.C. RWD No. 1 (Sparks)	Sparks Lake	350	0.024	--	0.026	0.049	74	0.060	0.027
L.C. RWD No. 2	City of Chandler	(440)	--	--	(0.022)	(0.030)	50	--	0.135
Meeker, city of	Meeker Lake	1,080	0.179	--	0.110	0.207	102	0.215	0.500
Prague, city of	Wells	2,500	--	0.626	0.576	0.981	230	--	0.682
Stroud, city of	Stroud Lake	3,200	1.161	--	0.388	0.730	121	0.750	0.350
Tryon, city of	Wells	435	--	0.026	0.026	0.028	60	--	0.085
Wellston, city of	Wells	750	--	0.075	0.074	0.126	99	--	0.230

1/ Source of use data: Water Supplies of Southeastern Oklahoma, draft report, TVA, July 1984, as occasionally modified with data from State agencies, SODA, and water user entities. Source of existing water supply data: Surface, table IX-2; and ground water, table IX-4.

2/ Treatment plant capacity of Coalgate PWA is currently being doubled.

3/ Originates in Okmulgee County; also serves in Okfuskee County. No data for Okfuskee County portion.

4/ Also serves in Pittsburg County.

5/ Also serves in Payne County.

6/ No data reported for Okfuskee County portion of service area for Salem RWC nor Okfuskee County portion of service area for Rural Water and Solid Waste Management District No. 3 (Seminole County); however, data is incorporated with Okemah.

7/ No data reported for Pawnee County portion of service area for Yale RWC (Payne County). Source of RWD No. 2, Inc., water supply is in Creek County (Mannford).

8/ Includes area served in Payne County.

9/ Small areas served by Morr Water, Inc. (Noble County) and RWD No. 3 (Pawnee County). No Payne County data reported. Area served by Big Creek RWC reported under Lincoln County.

10/ Includes data for area served in Pawnee County.

11/ Small areas served by RWD No. 1 (Garvin County) and RWD No. 1 (Murray County). No Pontotoc County data reported.

12/ Includes data for area served in Hughes County.

13/ Data includes area served in Seminole County.

14/ Data includes area of town served in Seminole County.

15/ Data for areas served by Earlsboro RWD (Water, Inc.) and city of Maud are reported in Pottawatomie County.

16/ Data includes area served in Okfuskee County.

(Sheet 2 of 4)

Table IX-8 (Continued)

Existing Water Supplies and Present M&I Use [1]

(East-Central Oklahoma Water Supply Study, January 1985)

Water User Entity	Source of Water Supply	Population Served	Estimated Yield of Existing Water Supplies		Average Daily Use (Mgal/d)	Peak Demands (Mgal/d)	Gallons Per Capita Per Day	Treatment Plant Capacity (Mgal/d)	Storage Capacity (Mgal)
			Surface (Mgal/d)	Ground Water (Mgal/d)					
OKFUSKEE [6]									
Okemah, city of (UA)	Okemah Lake	8,447	2.946	--	1.082	1.200	128	1.000	0.645
O.C. RWD No. 1 (Boley)	Wells	500	--	0.120	0.019	0.024	38	0.144	0.106
O.C. RWD No. 2	City of Okemah	(1,300)	--	--	(0.089)	(0.099)	68	--	0.212
O.C. RWD No. 3	City of Okemah	(1,245)	--	--	(0.115)	(0.140)	93	--	0.123
Paden, town of	Wells	500	--	0.050	0.041	0.046	82	None	0.087
Weleetka, town of	Weleetka Lake	1,800	0.179	--	0.191	0.332	106	0.270	0.087
PAWNEE [7]									
Blackburn-Skedee Water, Inc.	Wells	850	--	0.102	0.040	0.060	47	--	0.120
Cleveland, city of	Cleveland Reservoir	5,376	0.670	--	0.440	0.650	74	1.500	1.000
Hallett PWA	Wells	280	--	0.192	0.035	0.060	125	None	0.059
Jennings, town of	Wells	350	--	0.070	0.017	0.029	48	None	0.090
Pawnee, city of	Pawnee Lake	3,600	0.848	--	0.526	0.600	164	1.500	0.400
P.C. RWD No. 1	Wells	1,820	--	0.093	0.093	0.100	51	None	0.200
P.C. RWD No. 2, Inc.	City of Mannford (Creek County)	(450)	--	--	(0.031)	(0.038)	67	--	0.150
P.C. RWD No. 2 (Terlton)	(70%) City of Cleveland (30%) wells	252	--	0.075	0.020	0.025	81	None	0.200
P.C. RWD No. 3 [8]	City of Pawnee	(600)	--	--	(0.066)	(0.081)	110	--	None
Ralston PWA	Wells	560	--	0.290	0.050	0.080	90	None	0.055
Ralston RWC (Water, Inc.)	City of Ralston	(125)	--	--	(0.021)	(0.033)	165	--	0.022
Westport UAT	Wells	263	--	0.015	0.015	0.027	57	None	0.100

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[1] Source of use data: Water Supplies of Southeastern Oklahoma, draft report, TVA, July 1984, as occasionally modified with data from State agencies, SODA, and water user entities. Source of existing water supply data: Surface, table IX-2; and ground water, table IX-4.

[2] Treatment plant capacity of Coalgate PWA is currently being doubled.

[3] Originates in Okmulgee County; also serves in Okfuskee County. No data for Okfuskee County portion.

[4] Also serves in Pittsburg County.

[5] Also serves in Payne County.

[6] No data reported for Okfuskee County portion of service area for Salem RWC nor Okfuskee County portion of service area for Rural Water and Solid Waste Management District No. 3 (Seminole County); however, data is incorporated with Okemah.

[7] No data reported for Pawnee County portion of service area for Yale RWC (Payne County). Source of RWD No. 2, Inc., water supply is in Creek County (Mannford).

[8] Includes area served in Payne County.

[9] Small areas served by Morr Water, Inc. (Noble County) and RWD No. 3 (Pawnee County). No Payne County data reported. Area served by Big Creek RWC reported under Lincoln County.

[10] Includes data for area served in Pawnee County.

[11] Small areas served by RWD No. 1 (Garvin County) and RWD No. 1 (Murray County). No Pontotoc County data reported.

[12] Includes data for area served in Hughes County.

[13] Data includes area served in Seminole County.

[14] Data includes area of town served in Seminole County.

[15] Data for areas served by Earlsboro RWD (Water, Inc.) and city of Maud are reported in Pottawatomie County.

[16] Data includes area served in Okfuskee County.

(Sheet 3 of 4)

Table IX-8 (Continued)

Existing Water Supplies and Present M&I Use 1/

(East-Central Oklahoma Water Supply Study, January 1985)

Water User Entity	Source of Water Supply	Population Served	Estimated Yield of Existing Water Supplies: Surface (Mgal/d)	Estimated Yield of Existing Water Supplies: Ground Water (Mgal/d)	Average Daily Use (Mgal/d)	Peak Demands (Mgal/d)	Gallons Per Capita Per Day	Treatment Plant Capacity (Mgal/d)	Storage Capacity (Mgal)
PAYNE 9/									
Cushing, city of	(90%) Cushing Lake (10%) wells	8,600	1.607	0.360	1.200	3.700	140	4.000	2.000
51 East Water, Inc. (corporation)	City of Stillwater	(1,200)	--	--	(0.106)	(0.180)	88	--	0.200
Glencoe, town of	Wells	520	--	0.050	0.035	0.050	73	None	0.050
P.C. RWD No. 1	City of Stillwater	(470)	--	--	(0.054)	(0.091)	115	--	0.055
P.C. RWC No. 3 (corporation)	City of Stillwater	(1,400)	--	--	(0.140)	(0.193)	100	--	0.614
P.C. RWD No. 3	Wells	1,000	--	0.120	0.063	0.073	63	None	0.048
Perkins, town of	Wells	2,100	--	0.360	0.148	0.231	70	None	0.133
Ripley PWA	Wells	486	--	0.050	0.032	0.043	66	None	0.140
Stillwater, city of	Lakes Carl Blackwell and McMurtry	41,888	8.927	--	6.150	10.240	146	12.000 - OSU 12.000 - city	6.000
Yale, city of	Wells	2,400	--	0.600	0.292	0.361	122	None	0.175
Yale RWC (corporation) 10/	City of Yale	(600)	--	--	(0.043)	(0.106)	72	--	0.092
PONTOTOC 11/									
Ada, city of (PWA)	Bird's Mill Springs & wells	23,763	--	8.160	3.873	7.060	163	None	1.000
Allen PWA 12/	Wells	1,200	--	0.170	0.170	0.230	142	None	0.415
Francis, city of	Wells	420	--	0.115	0.060	0.065	143	None	0.080
P.C. RWD No. 1	City of Ada	(574)	--	--	(0.048)	(0.050)	84	--	0.103
P.C. RWD No. 2	City of Ada	(2,075)	--	--	(0.186)	(0.190)	90	--	0.208
P.C. RWD No. 3	City of Ada	(1,833)	--	--	(0.146)	(0.149)	80	--	None
P.C. RWD No. 4	City of Ada	(250)	--	--	(0.056)	(0.059)	224	--	None
P.C. RWD No. 5	City of Ada	(158)	--	--	(0.013)	(0.015)	82	--	None
P.C. RWD No. 6	City of Ada	(800)	--	--	(0.074)	(0.080)	93	--	0.185
P.C. RWD No. 7	City of Ada	(800)	--	--	(0.092)	(0.095)	115	--	None
P.C. RWD No. 8	City of Ada	(1,500)	--	--	(0.082)	(0.085)	55	--	0.380
Roff, town of	Wells	800	--	0.118	0.118	0.118	148	--	0.055
Stonewall, town of	Wells	800	--	0.070	0.068	0.071	85	--	0.160

1/ Source of use data: Water Supplies of Southeastern Oklahoma, draft report, TVA, July 1984, as occasionally modified with data from State agencies, SODA, and water user entities. Source of existing water supply data: Surface, table IX-2; and ground water, table IX-4.

2/ Treatment plant capacity of Coalgate PWA is currently being doubled.

3/ Originates in Okmulgee County; also serves in Okfuskee County. No data for Okfuskee County portion.

4/ Also serves in Pittsburg County.

5/ Also serves in Payne County.

6/ No data reported for Okfuskee County portion of service area for Salem RWC nor Okfuskee County portion of service area for Rural Water and Solid Waste Management District No. 3 (Seminole County); however, data is incorporated with Okemah.

7/ No data reported for Pawnee County portion of service area for Yale RWC (Payne County). Source of RWD No. 2, Inc., water supply is in Creek County (Mannford).

8/ Includes area served in Payne County.

9/ Small areas served by Morr Water, Inc. (Noble County) and RWD No. 3 (Pawnee County). No Payne County data reported. Area served by Big Creek RWC reported under Lincoln County.

10/ Includes data for area served in Pawnee County.

11/ Small areas served by RWD No. 1 (Garvin County) and RWD No. 1 (Murray County). No Pontotoc County data reported.

12/ Includes data for area served in Hughes County.

13/ Data includes area served in Seminole County.

14/ Data includes area of town served in Seminole County.

15/ Data for areas served by Earlsboro RWD (Water, Inc.) and city of Maud are reported in Pottawatomie County.

16/ Data includes area served in Okfuskee County.

(Sheet 4 of 4)

Table IX-8 (Continued)

Existing Water Supplies and Present M&I Use [1]

(East-Central Oklahoma Water Supply Study, January 1985)

Water User Entity	Source of Water Supply	Population Served	Estimated Yield of Existing Water Supplies: Surface (Mgal/d)	Estimated Yield of Existing Water Supplies: Ground Water (Mgal/d)	Average Daily Use (Mgal/d)	Peak Demands (Mgal/d)	Gallons Per Capita Per Day	Treatment Plant Capacity (Mgal/d)	Storage Capacity (Mgal)
POTTAWATOMIE									
Asher, city of (UDA)	Wells	450	--	0.025	0.021	0.031	46	None	0.052
Earlsboro RWD (Water, Inc.) 13/	Wells	2,500	--	0.300	0.205	0.300	82	None	0.547
McLoud, city of	Wells	1,550	--	0.306	0.110	0.200	73	None	0.550
Maud, city of 14/	Wells	1,550	--	0.180	0.164	0.175	106	None	0.285
P.C. RWD No. 1 (Bethel)	City of Shawnee	(1,000)	--	--	(0.058)	(0.078)	58	--	0.180
Shawnee, city of	Shawnee Reservoirs Nos. 1 and 2	25,000	3.303	--	3.406	5.792	139	8.000	2.000
St. Louis, city of (UA)	Wells	260	--	0.020	0.013	0.018	50	None	0.030
Tecumseh, city of	(73%) Tecumseh Reservoir (27%) Wells	5,128	0.312	0.170	0.555	0.620	108	1.000	1.100
Wanette, city of	Wells	478	--	0.050	0.030	0.070	63	None	0.075
SEMINOLE 15/									
Bowlegs, town of	Wells	450	--	0.030	0.017	0.028	30	None	0.0037
Bowlegs-Lima Water District	Wells	1,755	--	0.200	0.148	0.290	85	None	0.360
Cromwell, city of	RWD No. 3	(300)	--	--	(0.021)	(0.024)	70	--	0.040
Konawa, city of	Wells	1,750	--	0.205	0.205	0.239	117	None	0.300
Sasakwa, city of	Wells	442	--	0.018	0.018	0.020	40	None	0.060
Sasakwa RWD of the Seminole Nation	Wells	200	--	0.028	0.022	0.025	108	None	None
Seminole, city of	Wells	8,600	--	2.380	1.150	1.760	134	None	2.750
S.C. RWD No. 1	City of Wewoka	(400)	--	--	(0.017)	(0.032)	43	--	0.025
S.C. RWD No. 2	City of Wewoka	(418)	--	--	(0.027)	(0.031)	68	--	None
S.C. RW&SWMD No. 3 16/	City of Okemah (Okfuskee County)	(606)	--	--	(0.042)	(0.048)	70	--	0.040
S.C. RWD No. 5	City of Wewoka	(150)	--	--	(0.006)	(0.018)	40	--	None
Wewoka, city of	Wewoka Lake	6,458	0.893	--	0.687	1.306	106	1.400	1.925

1/ Source of use data: Water Supplies of Southeastern Oklahoma, draft report, TVA, July 1984, as occasionally modified with data from State agencies, SODA, and water user entities. Source of existing water supply data: Surface, table IX-2; and ground water, table IX-4.

2/ Treatment plant capacity of Coalgate PWA is currently being doubled.

3/ Originates in Okmulgee County; also serves in Okfuskee County. No data for Okfuskee County portion.

4/ Also serves in Pittsburg County.

5/ Also serves in Payne County.

6/ No data reported for Okfuskee County portion of service area for Salem RWC nor Okfuskee County portion of service area for Rural Water and Solid Waste Management District No. 3 (Seminole County); however, data is incorporated with Okemah.

7/ No data reported for Pawnee County portion of service area for Yale RWC (Payne County). Source of RWD No. 2, Inc., water supply is in Creek County (Mannford).

8/ Includes area served in Payne County.

9/ Small areas served by Morr Water, Inc. (Noble County) and RWD No. 3 (Pawnee County). No Payne County data reported. Area served by Big Creek RWC reported under Lincoln County.

10/ Includes data for area served in Pawnee County.

11/ Small areas served by RWD No. 1 (Garvin County) and RWD No. 1 (Murray County). No Pontotoc County data reported.

12/ Includes data for area served in Hughes County.

13/ Data includes area served in Seminole County.

14/ Data includes area of town served in Seminole County.

15/ Data for areas served by Earlsboro RWD (Water, Inc.) and city of Maud are reported in Pottawatomie County.

16/ Data includes area served in Okfuskee County.

Supply values presented in the following county and local narrative must be considered preliminary. They have been gathered from various sources and were determined at different levels of detail or accuracy. The values are shown in Mgal/d to three decimal places. This in no way implies a three-decimal point accuracy. It was done only for ease in comparison of estimated supply to demand. It also shows the 1,000 Mgal/d value for small users.

Storage in the following narrative refers only to temporary storage as defined in section D.2.c above.

(1) Coal County--Water supply problems reported for Coalgate were apparently restricted to water treatment plant capacity, which has just been expanded to 1 Mgal/d. Reclamation's firm yield estimate for Coalgate Reservoir shows a dependable supply 415 percent greater than current average daily use. Lehigh reports well capacity at 0.160 Mgal/d but also reports shortage problems with average daily use and peak demands at 0.045 and 0.050 Mgal/d, respectively. Treatment capacity and storage appear adequate. Reclamation estimates that dependable ground water capability is 0.045 Mgal/d, which is consistent for six wells in the minor Pennsylvanian sandstone aquifer. Because of the limited capability of this aquifer, purchase of supplemental or total supplies from Coalgate appears to be the most logical solution. Data for Tupelo are correct for the present but will change shortly. The city has undertaken an ambitious program of constructing additional wells, a water treatment facility, additional storage, and a newly designed system of delivery mains and lines. It plans to be self-sufficient in water supply, maintaining its connection with Coalgate via RWD No. 2 for emergency supply only.

(2) Hughes County--The town of Calvin reports well capacity of 0.108 Mgal/d but experiences episodes of required rationing with average daily use at 0.067 Mgal/d and peaks at 0.087 Mgal/d. Storage is adequate. Since the wells are in the Canadian River alluvium, Reclamation has estimated dependable well capability at 0.070 Mgal/d. Alluvial aquifers in this region tend to "drain out" during drought periods with resultant lower water tables that are much more likely to experience drawdowns when heavily pumped. Although additional wells will provide additional water, it is quite possible they will experience limited yield capability and not provide a good long-term solution. Calvin may wish to explore a longer range alternative of obtaining a dependable surface water supply, possibly from Holdenville. Dustin PWW reports shortages with rationing which appear to be associated with a treatment plant capacity of only 7,200 gallons per day (0.00072 Mgal/d). Average daily use is reported at 0.013 Mgal/d with peaks at 0.015 Mgal/d, nearly double the plant capacity. Storage is adequate and Reclamation's firm yield estimate for the reservoir is more than 10 times greater than present use. Holdenville has experienced water shortages which have been partly due to an old treatment plant with 1.000 Mgal/d capacity. This is being replaced by a new plant. Storage is adequate for average daily use of 0.900 Mgal/d and 1.000 Mgal/d peaks. Reclamation's estimated firm yield for Lake Holdenville is 2.053 Mgal/d, which is not consistent with the record of reported very low reservoir levels during drought periods. Reclamation will put a high priority on determining the reason for Lake Holdenville not producing yields near estimated firm yield expectations and will identify solutions to whatever the problem might be. Supply seems to be adequate with RWD No. 2 (Stuart) with no readily identifiable water supply problems. Wetumka has an average daily use of 0.311 Mgal/d and has peaks at 0.500 Mgal/d. Water treatment plant capacity is adequate and storage is minimally adequate. The city has consistently reported peak shortages due to inadequate reservoir yields in Lake Wetumka. Reclamation's firm yield estimate is 0.714 Mgal/d which indicates actual reservoir yield lower than estimated expectation. The reason for this lower reservoir yield needs to be determined, and additional supplies for mid- and long-range demands will be investigated.

Coalgate, county seat of Coal County, has an ample supply of water from Coalgate Reservoir, seen in the upper right center.

Holdenville, the county seat of Hughes County, provides a source of water supply for several rural water districts.

(3) Lincoln County--Big Creek RWC has been using its own ground water supply, which has experienced shortages. Average daily use has been 0.142 Mgal/d, and peak demands have been 0.165 Mgal/d. Big Creek RWC is a member of Tri-County Development Authority and will be purchasing treated surface water supplies from the Tri-County Development Authority when its new waterworks and conveyance system become operational in late 1985 or early 1986. Storage is barely adequate. The city of Carney uses a daily average of 0.070 Mgal/d and experiences peak demands of 0.130 Mgal/d. Storage is not adequate for peak demands. Wells logs indicate a capacity of 0.090 Mgal/d, which seems unlikely in that the city reports no shortage experiences. Dependable well capability data needs to be determined before Carney's future water supply needs can be assessed. Chandler, with 0.634 Mgal/d average daily use and 0.990 Mgal/d peak use, is a classic case of using drought carry-over storage for normal year operations as indicated by Reclamation's firm yield estimate of only 0.473 Mgal/d. There is ample treatment capacity, but storage is only one-third of peak demands. The city has been working with SCS to develop a new supply reservoir (Kickapoo Nations Watershed Site 1M) which will have a firm yield of 4.068 Mgal/d. Construction activities have begun with acquisition of damsite and reservoir rights-of-way. The RWD No. 1 (Sparks) appears to have a water supply problem. Reclamation's firm yield estimate for Sparks Lake is 0.024 Mgal/d, while average daily demands are 0.026 Mgal/d and peak use is 0.049 Mgal/d. Treatment capacity is adequate, but storage is not. RWD No. 1 has a high-priority, short-term problem, especially if the 75 percent of the Sparks community who are on individual wells should wish to obtain water service from the district. The city of Meeker uses an average of 0.110 Mgal/d with peak use at 0.207 Mgal/d. Treatment plant capacity of 0.215 Mgal/d is nearing its limits. Storage is adequate. Meeker has a high-priority, short-term need for additional water supplies based on Reclamation's firm yield estimate of 0.179 Mgal/d for Meeker Lake, which shall be addressed as this study progresses. Prague presently has a well system that produces an estimated capacity of 0.626 Mgal/d. It uses 0.576 Mgal/d on an average daily basis and has peak uses of 0.981 Mgal/d. Storage is somewhat inadequate. The city has sponsored the completed SCS construction of new reservoir (Robinson Creek Watershed Site 4M) having a firm yield of 0.491 Mgal/d which, combined with the ground water supply, is adequate for short-term needs. As of yet, the city has not constructed the necessary water treatment plant. The city of Stroud apparently has unresolved water supply problems. They presently obtain their water from Stroud Lake, which has an estimated firm yield of 1.161 Mgal/d. The city reports average daily use of 0.388 Mgal/d and peak demands of 0.730 Mgal/d. Treatment plant capacity is 0.750 Mgal/d, which is adequate for the immediate short term. Although they have not had to ration water, the city has apparently experienced shortages sufficient to cause them to drill 13 wells into the Ada-Vamoosa Aquifer. All of these wells were abandoned because of extremely low yields. Storage is only half of the peak demands, which may be part of their problem. Reclamation plans to follow up soon to determine if a supply problem exists and, if so, what its magnitude and nature are so that solutions may be formulated. Tryon has an average daily use of 0.026 Mgal/d with peaks at 0.028 Mgal/d. Estimated capacity of their wells is 0.026 Mgal/d. Storage is adequate but seasonal shortages have been reported. Tryon should have a high priority in determining how to best alleviate their short-term needs. Cost-benefit studies need to be done to determine if well production should be increased or whether it would be wiser to import water from another source such as Big Creek RWC or Chandler. The Wellston community has two problems. The quality of its water exceeds several secondary standards, and it experiences shortages. Its well field is estimated to have a capacity of 0.075 Mgal/d although it has produced peaks of 0.126 Mgal/d and average daily use of 0.074 Mgal/d. Storage is adequate. High priority should be given to determine whether or not it is more cost effective to expand well production and treat the water to improve quality or whether it is better to develop a new source of supply.

(4) Okfuskee County--Okemah has a total average daily use of 1.082 Mgal/d with 1.200 Mgal/d peaks. Its treatment plant capacity of 1.000 Mgal/d is inadequate as is its 0.645 million-gallon storage. The estimated firm yield of Okemah Lake is 2.946 Mgal/d, which is 2-1/2 times current peak demands. With peak demands of 0.332 Mgal/d and average daily use of 0.191 Mgal/d, the city of Weleetka needs supply improvements. Treatment plant capacity of 0.270 Mgal/d is being exceeded during peak periods. Storage at 0.087 million gallons is inadequate. The Weleetka Lake firm yield estimate is 0.179 Mgal/d. Weleetka needs to establish a high-priority in solving its immediate water supply and facilities deficiencies.

Chandler, county seat of Lincoln County, is one of the few municipalities in the study area that will have water supplies adequate to meet future needs.

Okemah is another municipality that has adequate supplies of water for future needs in Okemah Lake. It is also the county seat of Okfuskee County.

(5) Pawnee County--Current ground water supplies appear adequate for Blackburn-Skedee Water, Inc. However, there are plans to switch over to a surface water supply from the previously discussed Tri-County Development Authority in late 1985. The city of Cleveland uses 0.440 Mgal/d on an average daily basis and 0.650 Mgal/d at peak usage. It has a treatment plant capacity of 1.500 Mgal/d and they have adequate storage. Reclamation estimates a firm yield of 0.670 Mgal/d for Cleveland Lake. At first glance, the firm yield may seem too high for the reported 2 feet of water remaining in the reservoir in 1981; however, current use figures are now nearly 0.100 Mgal/d lower than at that time when the city still supplied RWD No. 1. Nonetheless, the city will soon need a supplemental water supply. They have been negotiating for such a supply with the Tri-County Development Authority which has water available. The towns of Hallett and Jennings both have adequate ground water supplies. Hallett, however, needs additional storage. Pawnee has experienced water distribution or supply shortages in providing 0.526 Mgal/d average daily use and 0.600 Mgal/d for peak demands. Treatment plant capacity is adequate at 1.500 Mgal/d. The 0.400 Mgal/d storage is inadequate and may be part of the problem. It would appear that Pawnee Lake is not producing up to Reclamation's estimated firm yield of 0.848 Mgal/d. This is not critical since Pawnee will soon be receiving a supplemental supply of water from Tri-County Development Authority.

The RWD No. 1 now obtains its water from wells although it formerly purchased water from the city of Cleveland. The estimated 0.093 Mgal/d of well capability is barely adequate to supply an average daily use of 0.093 Mgal/d with peaks at 0.100 Mgal/d. Storage is adequate. Should the city actually obtain additional supplies from Tri-County Development Authority, the solution would be for RWD No. 1 to resume purchase of water from the city of Cleveland. If not, RWD No. 1 might attempt purchase of its own supply from Tri-County Development Authority.

The RWD No. 2, Inc., purchases water from the city of Mannford in Creek County. Water supplies are presently adequate as is its storage. Followup evaluations are needed to assure Mannford will have supplies for the district's long-term needs. The RWD No. 2 (Terlton) has adequate storage. It supplies 30 percent of its use with well water and the remaining 70 percent is purchased from the city of Cleveland. The adequacy of this supply portion is dependent upon the city of Cleveland resolving its own water problems. Ralston PWA has a ground water production capability of 0.290 Mgal/d, which is 363 percent greater than peak demands of 0.080 Mgal/d. Average daily use is 0.050 Mgal/d. Storage is inadequate. Westport UAT has a high-priority, short-term water supply need. It uses 0.015 Mgal/d on a daily average and .027 Mgal/d during peaks. Storage is adequate, but its estimated well production capability is only 0.015 Mgal/d. The restricted water supply situation at Westport and RWD No. 1 will require followup evaluations to determine their best alternatives.

The county seat of Pawnee County is the city of Pawnee, which will assure its future water supply with supplemental supply purchases from the Tri-County Development Authority.

Stillwater, county seat of Payne County, has assured its future water supply by building a pipeline to deliver supplemental water from Kaw Reservoir.

(6) Payne County--The city of Cushing depends on Cushing Lake for 90 percent of its supply which has an estimated firm yield of 1.607 Mgal/d, and 10 percent ground water which has an estimated dependable capability of 0.360 Mgal/d, for a total supply of 1.967 Mgal/d. Average daily use is 1.200 Mgal/d and peaks are at 3.700 Mgal/d. Treatment plant capacity is possibly adequate at 4.000 Mgal/d, but antiquated facilities need renovation or replacement. Storage facilities are inadequate at 2.000 million gallons. The city of Cushing has a high-priority immediate problem with water supply since its estimated total water supply is only 53 percent of current peak demands. The city should explore the most timely and cost-effective solutions to its water supply problem. The city of Glencoe is at the capacity of its present ground water supply and has inadequate storage. Its supply problems will be solved when it begins taking delivery of Tri-County Development Authority water in late 1985. The RWC No. 3 uses a ground water supply whose estimated capacity is 0.120 Mgal/d, which supplies an average daily 0.063 Mgal/d and peak use of 0.073 Mgal/d. The supply is more than adequate, but storage is not sufficient for emergency needs. The town of Perkins also

has inadequate storage but more than adequate ground water supplies. Ripley PWA has more than adequate storage and a ground water supply adequate for present peak demands. The city of Stillwater presently utilizes water supplies from Lakes Carl Blackwell and McMurtry having firm yields of 6.249 and 2.678 Mgal/d, respectively, for a total firm yield of 8.927 Mgal/d. Oklahoma State University holds the water rights to Carl Blackwell, and the city holds the water rights for McMurtry. Average daily use has been 6.150 Mgal/d with 10.240 Mgal/d peaks. The city is constructing a new water treatment plant which will equal the 12 Mgal/d capacity of the existing OSU plant for a combined total of 24.000 Mgal/d. Because their existing total firm water supply was less than their peak demands, the city contracted for an additional supply of water from Kaw Reservoir. A 36-inch pipeline will initially deliver up to 13.000 Mgal/d to the new treatment plant. This will make the new total supply nearly 22.000 Mgal/d. Approximately 75 percent of the city's total peak demand is expected to be met with water supplies from Kaw Reservoir. Lake McMurtry will be held in reserve for future growth and peak demands. The OSU needs are approximately 25 percent of the combined water supply demand and will be met with supplies from Lake Carl Blackwell. Stillwater's storage is inadequate. Currently, the city of Yale has adequate ground water supplies and inadequate storage. However, they are replacing their ground water with treated surface water supplies from Tri-County Development Authority.

(7) Pontotoc County--Ada PWA supplies the city of Ada, several outlying communities, and eight rural water water districts. Average daily use is 3.873 Mgal/d, and 7.060 Mgal/d is the peak demand. Estimated ground water capabilities are 8.160 Mgal/d which is adequate for present needs. Storage facilities appear to be inadequate. Ada's water is very hard. In the past, the city has shown an interest in replacing its supply with good quality surface water. Reclamation would be willing to assist the city in developing such plans should the city indicate a desire to have Reclamation do so. Allen PWA obtains its ground water supply from Canadian River alluvium. Estimated capable water supply is 0.170 Mgal/d. The system provides average daily supplies of 0.170 Mgal/d and peak supplies of 0.230 Mgal/d. Storage is more than adequate. The city experiences shortages during some peak demands which may be due to significantly lowered water tables in the alluvium during drought periods. Allen has a high-priority need to develop an adequate, fully dependable water supply. The city of Francis has adequate water supply and storage facilities. The town of Roff has a dependable water supply capability of 0.118 Mgal/d. Average daily use and peak demands are the same at 0.118 Mgal/d. The town has a high-priority need for additonal water supplies for itself and to enable the town to supply additional customers in the surrounding rural area. Roff also needs additional storage. The town of Stonewall also has an inadequate ground water supply capability at 0.070 Mgal/d which may not meet their 0.068 Mgal/d average daily use and 0.071 Mgal/d peaks. Storage is adequate. Stonewall also has a high-priority need to develop additional water supplies.

(8) Pottawatomie County--Asher UDA provides 0.031 Mgal/d peak demand and 0.021 Mgal/d average daily use with ground water supplies from Canadian River alluvium having an estimated capability of 0.025 Mgal/d. As might be expected, it experiences peak demand shortages during drought periods. Storage is adequate. Asher has a high-priority need to develop a fully dependable additional water supply. Earlsboro Water, Inc., uses a ground water supply with an estimated capable supply of 0.300 Mgal/d. Average daily use is 0.205 Mgal/d and peak use is 0.300 Mgal/d. No shortages have been reported. Storage is adequate. Earlsboro has a need to develop additional near-term supplies to meet increasing peak demands. The city of McLoud has an adequate supply of ground water to supply average daily use of 0.164 Mgal/d and peak use of 0.175 Mgal/d. Storage is also adequate. The city of Maud supplies peak demands of 0.200 Mgal/d and an average daily use of 0.110 Mgal/d from a ground water supply estimated to have a capable supply of 0.306 Mgal/d. Storage is also adequate. The city of Shawnee has the most critical present-term water supply problem in the entire study area. It is also one of the more complicated to explain. Shawnee is currently obtaining its water from Shawnee Reservoirs Nos. 1 and 2 (which are interconnected), which have an estimated firm yield of 3.303 Mgal/d. Average daily use is 3.406 Mgal/d and peak demands are 5.792 Mgal/d. Under sustained drought conditions over several years, Shawnee could not even meet average daily needs. The city has built a pipeline turnout from the Oklahoma City Aqueduct (which conveys water from Atoka Reservoir to Stanley Draper Lake) to Shawnee Reservoir No. 1. No firm amount of supply can be listed because the plan is for Shawnee to purchase emergency supplemental supplies when needed if supplies are available from Oklahoma City. There is no assurance that Oklahoma City could spare enough water to meet all of Shawnee's needs during a prolonged drought. The Pottawatomie County Development Authority has been working with SCS in developing plans for a water supply reservoir at North Deer Creek Watershed Site 1M. The SCS calculates the potential critical year yield (similar to firm yield) at 1.803 Mgal/d. Pottawatomie County Development Authority's present proposed allocation is that Shawnee would receive 75 percent and the city of Tecumseh would receive 25 percent of the water, with the stipulation that the city of Shawnee would supply Pottawatomie County Development Authority with up to 0.850 Mgal/d treated water for developing rural water systems in the more remote parts of the county. The additional firm supply realized by Shawnee would be 1.803 Mgal/d times 75 percent minus 0.850 Mgal/d or a new total of 0.502 Mgal/d. This amount when added to the existing 3.303 Mgal/d would provide a total firm yield of 3.805 Mgal/d, which still would be inadequate to meet current peak demand needs. The Pottawatomie County Development Authority had hoped to have the North Deer Creek plan approved and funded within the next 2 or 3 years. The Administration in Washington has proposed reductions is SCS appropriations and reducing its mission to a role of providing technical advice. Should this proposal be implemented, it is doubtful that SCS will be able to develop the reservoir on North Deer Creek. Either way, Shawnee's present water supply situation remains extremely critical. The St. Louis UA has an estimated capable ground water supply of 0.020 Mgal/d which is adequate for near-term 0.13 Mgal/d average daily use and peaks of 0.018 Mgal/d. Storage is adequate. Tecumseh presently uses a combination of surface and ground water for its supply. Estimated capable well supplies is 0.170 Mgal/d while the firm yield of Tecumseh Reservoir is estimated at 0.312 Mgal/d for a total supply of 0.482 Mgal/d. This is also a critical situation since average daily use is

Ada is the county seat of Pontotoc County, which is the only county relying exclusively on ground water supplies. Ada PWA supplies water to several communities and eight rural water districts.

Shawnee is county seat of Pottawatomie County and serves as headquarters for the Central Oklahoma Economic Development District and the Pottawatomie County Development Authority.

Seminole is the county seat of Seminole County.

Wewoka is one of the municipalities that needs additional water supplies.

Weleetka is located in southeast Okfuskee County. This community, like many others in the study area, has immediate water supply and facilities deficiencies.

The city of Meeker, Lincoln County, has identified a high-priority, short-term need for a supplemental water supply.

The Arkansas River meanders along the northern boundary of Pawnee County. This major stream is a valuable resource to the State and the general study area.

View of the Hickory Ridge area along the North Canadian River. Typical scene of the terrain features in east-central Oklahoma.

0.555 Mgal/d with peaks of 0.620 Mgal/d. If the North Deer Creek Watershed Site 1M is developed and if Tecumseh receives the proposed 25 percent allocation, 0.451 Mgal/d would be added to the city's supply, making Tecumseh's total water supply of 0.933 Mgal/d which is more than enough for near-term needs. However, Tecumseh's water supply problems must be given a high-priority until development of North Deer Creek is assured.

Wanette is supplied by two wells having an estimated capable supply of 0.050 Mgal/d. Average daily use is 0.030 Mgal/d with peaks at 0.070 Mgal/d. Storage is adequate. The supply from the two wells in service is inadequate. However, the city has developed two new wells which should result in a plentiful water supply when they are integrated into system operations.

(9) Seminole County--The town of Bowlegs has a minimally adequate ground water supply whose capability is estimated at 0.030 Mgal/d. Peak demands are 0.028 Mgal/d with 0.017 Mgal/d used on an average daily basis. Storage is adequate. The existing wells of the Bowlegs-Lima Water District have an inadequate estimated capable supply of 0.200 Mgal/d to meet peak demands of 0.290 Mgal/d. Average daily use is 0.148 Mgal/d. The district is planning to develop two additional wells in the Ada-Vamoosa Formation, one to meet peak demands and one for emergency standby. This should take care of their short-term needs. Storage is adequate. The city of Konawa obtains its water from wells in the Canadian River alluvium. Estimated capable supply is 0.205 Mgal/d which is inadequate for peak demands of 0.239 Mgal/d and 0.205 Mgal/d average daily use. There are reported water quality problems. Although additional wells would provide short-term water supply relief, the addition of needed water treatment facilities to improve quality might make it more cost effective to obtain a new, better quality water supply from a regional supply source. Storage is adequate. The city of Sasakwa obtains an estimated capable supply of 0.018 Mgal/d from its wells which is inadequate for peak demands of 0.020 Mgal/d and average daily use of 0.018 Mgal/d. Storage is adequate. The Sasakwa RWD of the Seminole Nation also uses ground water to provide 0.022 Mgal/d average daily use and 0.025 Mgal/d for peaks. Estimated capable supply is 0.028 Mgal/d, which is marginal. The district has no storage. Both the city and the district were featured in newspaper articles during the winter of 1984-1985 describing the shortage and water quality problems both entities were experiencing. The articles described the frustration at being unable to develop new wells supplies because water could not be found or, when it was, it was brine contaminated and unsuitable for use. Both entities have a high-priority need to import an adequate supply of suitable quality water. The city of Seminole appears to have an adequate water system. Its wells produced an estimated capable supply of 2.380 Mgal/d. Average daily use is 1.150 Mgal/d with 1.760 Mgal/d peak demands. Storage is adequate. The 1.400-Mgal/d-capacity Wewoka treatment plant provides treated water supplies for an average daily use of 0.687 Mgal/d and peak demands of 1.306 Mgal/d. Reclamation's estimated firm yield for Wewoka Lake is 0.893 Mgal/d which is inadequate for present demands. Storage is adequate. Wewoka has a need for additional supply development.

3. Projected future M&I water demands. Since Reclamation's 4-year special study was only begun several months ago, social assessment has just begun that will help determine what the most likely future for the study area will be. This special study has not yet obtained enough information to attempt making population projections, the projections in chapter II were obtained from the Corps, who has been studying a number of counties around and near the study area for several years. These projections are preliminary, so Reclamation may modify or improve these projections after it has had an opportunity to complete more detailed studies. For the same reasons, projected future water demand (based on population projections) data from the Corps was utilized in developing the water demand projections. As in the population projections in chapter II, two different projections are displayed for each decade for comparison purposes. The SEDIP projection stands for "Successful Economic Development Initiative Plans" which is the Corps' forecast of conditions resulting from overall achievement of the RedArk Comprehensive Economic Development Plan. The OESC (Oklahoma Employment Security Commission) projection is a forecast of the future based on continuation of historic and present trends. Tables IX-9 through IX-17 provide detailed comparative water demand projections for the decades 1990 through the year 2040 for each of the study area counties. Table IX-18 provides the same information as a summary table for the study area.

These tables are organized and work differently than the population projections in chapter II, which list all of the communities in a county and their projected population. Tables IX-9 through IX-17 list communities and rural water districts as water user entities. Populations listed are populations served with water by the entity, which is usually different than the exact census count. The communities and districts that purchase their water are listed under the entity from whom water is obtained. Populations served and projected water demands are included in the totals of the source entity. In other words, these tables are organized on a sources of water supply basis for each county.

Projected populations served are multiplied by the number of gallons per capita per day in calculating the projected water demand in thousands of gallons per day. This, then, is divided by 1 million to convert the number to Mgal/d which is the standard unit of measure for M&I water supplies.

These tables are useful for detailed analyses in planning work for each entity, but they do not lend themselves to easy reference in a generalized discussion of projected mid-range (year 2010) and long-range (year 2040) needs. Table IX-19 was developed for this purpose. It lists the SEDIP and OESC water demand projections for the years 2010 and 2040, which were taken from tables IX-9 through IX-17. They also list the available water supplies that exist or that are under construction and will be in use before the first projection decade (year 1990). This allows easy comparison of projected demands against available supplies. Only those entities that have sources of water supply for themselves and/or others are listed. Most of the entities have maximum projected water demands

Table IX-9
Detailed Comparative Water Demand Projections for Coal County [1]
(East-Central Oklahoma Water Supply Study, January 1985)

Coal County Water User Entity	Year 1990					Year 2000					Year 2010				
	SEDIP [2] Projections		Gallons	OESC [3] Projections		SEDIP Projections		Gallons	OESC Projections		SEDIP Projections		Gallons	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)
Coalgate PWA (supplies RWD Nos. 1, 2, and 5, Clarita-Olney Water Co., Inc., and Round Hill Water Co, Inc. No. 4) [4]	0.426	4,625	92.0	4,338	0.399	0.488	5,035	97.0	4,394	0.426	0.560	5,487	102.0	4,355	0.444
RWD No. 1 (includes Phillips)	(0.044)	(820)	(54.0)	(760)	(0.041)	(0.048)	(820)	(59.0)	(710)	(0.042)	(0.057)	(890)	(64.0)	(700)	(0.045)
RWD No. 2 (includes Centrahoma) [5]	(0.043)	(609)	(70.0)	(573)	(0.040)	(0.060)	(800)	(75.0)	(700)	(0.053)	(0.078)	(973)	(80.0)	(773)	(0.062)
RWD No. 5	(0.018)	(220)	(84.0)	(210)	(0.018)	(0.019)	(210)	(89.0)	(190)	(0.017)	(0.019)	(200)	(94.0)	(160)	(0.015)
Clarita-Olney Water Co., Inc.	(0.047)	(590)	(79.0)	(550)	(0.043)	(0.048)	(570)	(84.0)	(500)	(0.042)	(0.048)	(540)	(89.0)	(430)	(0.038)
Round Hill Water Co., Inc. No. 4 [6]	(0.010)	(236)	(44.0)	(225)	(0.010)	(0.011)	(225)	(49.0)	(204)	(0.010)	(0.012)	(214)	(54.0)	(172)	(0.009)
Lehigh PWA	0.042	340	124.0	320	0.040	0.048	370	129.0	320	0.041	0.043	320	134.0	250	0.034
Tupelo PWA [7]	0.043	690	63.0	650	0.041	0.063	920	68.0	800	0.054	0.082	1,130	73.0	900	0.066
County Total	0.511	5,655		5,308	0.480	0.599	6,325		5,514	0.521	0.685	6,937		5,505	0.544

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[1] Source: Corps of Engineers, data sheets, December 1984.
[2] SEDIP = Successful Economic Development Initiative Plans.
[3] OESC = Oklahoma Employment Security Commission.
[4] Corps' data modified to remove people served and water supplied to Tupelo and further modified to add populations served and water supplies provided to RWD No. 5 and Round Hill Water Co., Inc. No. 4.
[5] Corps' data modified to remove population served and water supplied to Tupelo.
[6] All data for this entity added. Not reported by the Corps.
[7] Tupelo is in the process of obtaining additional ground water supplies, constructing a treatment facility, and adding to treated storage capability. It plans to be 100 percent self-supplied when these activities are completed, relying on Coalgate solely as an emergency back-up supply. Corps' data modified to reflect the same.

Table IX-9 (Continued)
Detailed Comparative Water Demand Projections for Coal County [1]
(East-Central Oklahoma Water Supply Study, January 1985)

Coal County Water User Entity	Year 2020 SEDIP [2] Projections Average Daily Use (Mgal/d)	Year 2020 SEDIP [2] Projections Population Served	Year 2020 Gallons Per Capita Per Day	Year 2020 OESC [3] Projections Population Served	Year 2020 OESC [3] Projections Average Daily Use (Mgal/d)	Year 2030 SEDIP Projections Average Daily Use (Mgal/d)	Year 2030 SEDIP Projections Population Served	Year 2030 Gallons Per Capita Per Day	Year 2030 OESC Projections Population Served	Year 2030 OESC Projections Average Daily Use (Mgal/d)	Year 2040 SEDIP Projections Average Daily Use (Mgal/d)	Year 2040 SEDIP Projections Population Served	Year 2040 Gallons Per Capita Per Day	Year 2040 OESC Projections Population Served	Year 2040 OESC Projections Average Daily Use (Mgal/d)
Coalgate PWA (supplies RWD Nos. 1, 2, and 5, Clarita-Olney Water Co., Inc., and Round Hill Water Co, Inc. No. 4) [4]	0.632	5,905	107.0	4,296	0.460	0.704	6,288	112.0	4,086	0.458	0.786	6,715	117.0	3,887	0.455
RWD No. 1 (includes Phillips)	(0.066)	(950)	(69.0)	(690)	(0.048)	(0.076)	(1,030)	(74.0)	(670)	(0.050)	(0.088)	(1,120)	(79.0)	(650)	(0.051)
RWD No. 2 (includes Centrahoma) [5]	(0.100)	(1,182)	(85.0)	(855)	(0.073)	(0.129)	(1,436)	(90.0)	(937)	(0.084)	(0.167)	(1,755)	(95.0)	(1,010)	(0.096)
RWD No. 5	(0.019)	(190)	(99.0)	(140)	(0.014)	(0.018)	(170)	(104.0)	(110)	(0.011)	(0.015)	(140)	(109.0)	(80)	(0.009)
Clarita-Olney Water Co., Inc.	(0.047)	(500)	(94.0)	(370)	(0.035)	(0.045)	(450)	(99.0)	(290)	(0.029)	(0.038)	(370)	(104.0)	(220)	(0.023)
Round Hill Water Co., Inc. No. 4 [6]	(0.012)	(203)	(59.0)	(151)	(0.009)	(0.012)	(182)	(64.0)	(119)	(0.008)	(0.010)	(150)	(69.0)	(87)	(0.006)
Lehigh PWA	0.049	350	139.0	250	0.035	0.042	290	144.0	190	0.027	0.031	210	149.0	130	0.019
Tupelo PWA [7]	0.108	1,380	78.0	1,000	0.078	0.140	1,690	83.0	1,100	0.091	0.183	2,080	88.0	1,200	0.106
County Total	0.789	7,635		5,546	0.573	0.886	8,268		5,376	0.576	1.000	9,005		5,217	0.580

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[1] Source: Corps of Engineers, data sheets, December 1984.
[2] SEDIP = Successful Economic Development Initiative Plans.
[3] OESC = Oklahoma Employment Security Commission.
[4] Corps' data modified to remove people served and water supplied to Tupelo and further modified to add populations served and water supplies provided to RWD No. 5 and Round Hill Water Co., Inc. No. 4.
[5] Corps' data modified to remove population served and water supplied to Tupelo.
[6] All data for this entity added. Not reported by the Corps.
[7] Tupelo is in the process of obtaining additional ground water supplies, constructing a treatment facility, and adding to treated storage capability. It plans to be 100 percent self-supplied when these activities are completed, relying on Coalgate solely as an emergency back-up supply. Corps' data modified to reflect the same.

Table IX-10

Detailed Comparative Water Demand Projections for Hughes County 1/

(East-Central Oklahoma Water Supply Study, January 1985)

Hughes County 2/ Water User Entity	Year 1990					Year 2000					Year 2010				
	SEDIP 3/ Projections		Gallons Per Capita Per Day	OESC 4/ Projections		SEDIP Projections		Gallons Per Capita Per Day	OESC Projections		SEDIP Projections		Gallons Per Capita Per Day	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)
Calvin	0.073	370	196	330	0.065	0.072	360	201	275	0.055	0.082	400	206	275	0.057
Dustin	0.017	590	28.4	535	0.015	0.022	670	33.4	535	0.018	0.027	700	38.4	490	0.019
Gerty (all individual wells)	0.006	170	34	150	0.005	0.007	190	39	150	0.006	0.010	220	44	150	0.007
Holdenville (supplies RWD Nos. 3 & 4) 5/	1.040	7,075	147	6,405	0.942	1.194	7,855	152	6,165	0.937	1.346	8,575	157	5,805	0.911
RWD No. 3 (serves Lamar	(0.048)	(500)	(96)	(410)	(0.039)	(0.051)	(500)	(101)	(400)	(0.040)	(0.053)	(500)	(106)	(400)	(0.042)
Lamar	[0.013]	[140]	[96]	[100]	[0.010]	[0.017]	[170]	[101]	[100]	[0.010]	[0.021]	[200]	[106]	[100]	[0.011]
RWD No. 4 (includes Atwood)	(0.057)	(510)	(112)	(460)	(0.052)	(0.060)	(510)	(117)	(400)	(0.047)	(0.062)	(510)	(122)	(340)	(0.041)
Wetumka (supplies RWD No. 1) 6/	0.345	2,735	126	2,525	0.318	0.394	3,005	131	2,465	0.323	0.462	3,135	136	2,375	0.323
RWD No. 1	(0.034)	(850)	(40)	(760)	(0.030)	(0.038)	(840)	(45)	(700)	(0.032)	(0.042)	(840)	(50)	(570)	(0.029)
Yeager (all individual wells)	0.006	170	34	150	0.005	0.007	190	39	150	0.006	0.010	220	44	150	0.007
RWD No. 2 (includes Ashland, Haywood, Hickory Hills, and a small area in Pittsburg, CO) (serves Stuart)	0.035	720	48	740	0.036	0.038	710	53	600	0.032	0.041	710	58	600	0.035
Stuart	(0.019)	(350)	(54)	(250)	(0.014)	(0.018)	(310)	(59)	(200)	(0.012)	(0.023)	(360)	(64)	(200)	(0.013)
County Totals	1.522	11,830		10,835	1.386	1.734	12,980		10,340	1.377	1.978	13,960		9,845	1.359

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ Hughes County portion of the town of Allen reported under Pontotoc County. No data provided for area served by Salem RWC, which originates in Okmulgee County. RWD No. 5 is under construction--no data available.
3/ SEDIP = Successful Economic Development Initiative Plans.
4/ OESC = Oklahoma Employment Security Commission.
5/ Corps' populations reduced by 325 to correct water service to RWD Nos. 3 & 4, instead of RWD Nos. 2 & 3. Gallons per capita were increased to reflect 1982 average daily use of 900,000 gal/d as reported by TVA.
6/ Populations increased by 375 to reflect total population of RWD No. 1 and gallons per capita were increased to reflect 1982 average daily use of 311,000 gal/d as reported by TVA.

Table IX-10 (Continued)

Detailed Comparative Water Demand Projections for Hughes County [1]

(East-Central Oklahoma Water Supply Study, January 1985)

	Year 2020					Year 2030					Year 2040				
	SEDIP [3] Projections		Gallons	OESC [4] Projections		SEDIP Projections		Gallons	OESC Projections		SEDIP Projections		Gallons	OESC Projections	
Hughes County [2] Water User Entity	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)
Calvin	0.080	380	211	220	0.046	0.076	350	216	165	0.036	0.059	280	221	110	0.024
Dustin	0.036	820	43.4	480	0.021	0.043	880	48.4	430	0.021	0.049	920	53.4	370	0.020
Gerty (all individual wells)	0.013	260	49	150	0.007	0.017	310	54	150	0.008	0.022	370	59	150	0.009
Holdenville (supplies RWD Nos. 3 & 4) [5]	1.509	9,315	162	5,325	0.863	1.667	9,985	167	4,715	0.787	1.822	10,595	172	4,115	0.708
RWD No. 3 (serves Lamar)	(0.053)	(480)	(111)	(200)	(0.022)	(0.055)	(470)	(116)	(200)	(0.023)	(0.056)	(460)	(121)	(200)	(0.024)
Lamar	[0.013]	[120]	[111]	[50]	[0.006]	[0.015]	[130]	[116]	[50]	[0.006]	[0.019]	[160]	[121]	[50]	[0.006]
RWD No. 4 (includes Atwood)	(0.062)	(490)	(127)	(290)	(0.037)	(0.063)	(480)	(132)	(230)	(0.030)	(0.064)	(470)	(137)	(180)	(0.025)
Wetumka (supplies RWD No. 1) [6]	0.479	3,395	141	2,245	0.317	0.507	3,475	146	1,995	0.291	0.526	3,485	151	1,735	0.262
RWD No. 1	(0.045)	(820)	(55)	(470)	(0.026)	(0.047)	(790)	(60)	(380)	(0.230)	(0.050)	(770)	(65)	(300)	(0.020)
Yeager (All individual wells)	0.008	170	49	100	0.005	0.011	200	54	100	0.005	0.015	250	59	100	0.006
RWD No. 2 (includes Ashland, Haywood Hickory Hills, and a small area in Pittsburg, CO) (serves Stuart)	0.043	690	63	450	0.028	0.046	670	68	450	0.031	0.047	650	73	450	0.033
Stuart	(0.022)	(320)	(69)	(150)	(0.010)	(0.028)	(380)	(74)	(150)	(0.011)	(0.036)	(460)	(79)	(150)	(0.012)
County Totals	2.168	15,030		8,970	1.287	2.367	15,870		8,005	1.179	2.540	16,550		7,030	1.062

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[1] Source: Corps of Engineers, data sheets, December 1984.

[2] Hughes County portion of the town of Allen reported under Pontotoc County. No data provided for area served by Salem RWC, which originates in Okmulgee County. RWD No. 5 is under construction--no data available.

[3] SEDIP = Successful Economic Development Initiative Plans.

[4] OESC = Oklahoma Employment Security Commission.

[5] Corps' populations reduced by 325 to correct water service to RWD Nos. 3 & 4, instead of RWD Nos. 2 & 3. Gallons per capita were increased to reflect 1982 average daily use of 900,000 gal/d as reported by TVA.

[6] Populations increased by 375 to reflect total population of RWD No. 1 and gallons per capita were increased to reflect 1982 average daily use of 311,000 gal/d as reported by TVA.

Table IX-11

Detailed Comparative Water Demand Projections for Lincoln County [1]

(East-Central Oklahoma Water Supply Study, January 1985, Rev. 2/85)

Lincoln County [2] Water User Entity	Year 1990					Year 2000					Year 2010				
	SEDIP [3] Projections		Gallons Per Capita Per Day	OESC [4] Projections		SEDIP Projections		Gallons Per Capita Per Day	OESC Projections		SEDIP Projections		Gallons Per Capita Per Day	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)
Carney	0.092	1,010	91.5	970	0.089	0.134	1,390	96.5	1,280	0.124	0.173	1,700	101.5	1,520	0.154
Chandler (supplies Davenport & RWD No. 2)	0.543	4,450	122	4,290	0.523	0.613	4,830	127.0	4,430	0.563	0.675	5,110	132	4,560	0.602
Davenport	(0.070)	(1,140)	(61)	(1,100)	(0.067)	(0.083)	(1,250)	(66.0)	(1,150)	(0.076)	(0.092)	(1,290)	(71.0)	(1,150)	(0.082)
RWD No. 2	(0.033)	(620)	(54)	(600)	(0.032)	(0.044)	(740)	(59.0)	(680)	(0.040)	(0.054)	(840)	(64.0)	(750)	(0.048)
Fallis (all individual wells)	0.002	50	34	50	0.002	0.002	50	39.0	50	0.002	0.002	50	44	50	0.002
Kendrick (all individual wells)	0.005	150	34	150	0.005	0.004	100	39.0	100	0.004	0.004	100	44	100	0.004
Meeker	0.150	1,350	110.8	1,300	0.144	0.201	1,740	115.8	1,600	0.185	0.257	2,130	120.8	1,900	0.230
Prague	0.711	3,040	234	2,930	0.686	0.848	3,550	239.0	3,250	0.777	1.020	4,130	244	3,690	0.900
Sparks (76% on individual wells with remaining 24% served by RWD No. 1) [5]	0.029	866	34	836	0.028	0.047	1,200	39.0	1,100	0.043	0.071	1,620	44	1,440	0.063
Stroud	0.374	3,780	99	3,640	0.360	0.469	4,510	104.0	4,130	0.430	0.563	5,180	109	4,630	0.505
Tryon	0.034	520	66	500	0.033	0.050	700	71.0	640	0.045	0.063	830	76	730	0.055
Warwick (all individual wells)	0.010	280	34	270	0.009	0.011	290	39.0	270	0.011	0.013	290	44	270	0.012
Wellston	0.088	850	104	820	0.085	0.108	990	109.0	910	0.099	0.123	1,080	114	960	0.109
RWD No. 1 (includes 24% of Sparks)	0.034	430	79	420	0.033	0.044	520	84.0	470	0.039	0.053	590	89	530	0.047
County Total	2.072	16,766		16,176	1.997	2.531	19,870		18,230	2.322	3.017	22,810		20,380	2.683

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[1] Source: Corps of Engineers, data sheets, December 1984.
[2] Big Creek RWC is reported in Pawnee County under Tri-County Development Authority, which will be its water supply source.
[3] SEDIP = Successful Economic Development Initiative Plans.
[4] OESC = Oklahoma Employment Security Commission.
[5] Corps' data modified to show that about 76 percent of Sparks is served by individual wells with the remainder included in RWD No. 1.

Table IX-11 (Continued)
Detailed Comparative Water Demand Projections for Lincoln County [1]
(East-Central Oklahoma Water Supply Study, January 1985, Rev. 2/85)

Lincoln County [2] Water User Entity	Year 2020					Year 2030					Year 2040				
	SEDIP [3] Projections		Gallons Per Capita Per Day	OESC [4] Projections		SEDIP Projections		Gallons Per Capita Per Day	OESC Projections		SEDIP Projections		Gallons Per Capita Per Day	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)
Carney	0.223	2,090	106.5	1,820	0.194	0.282	2,530	111.5	2,130	0.237	0.346	2,970	116.5	2,430	0.283
Chandler (supplies Davenport & RWD No. 2)	0.717	5,230	137	4,560	0.625	0.770	5,420	142	4,560	0.648	0.819	5,570	147	4,560	0.670
Davenport	(0.100)	(1,320)	(76)	(1,150)	(0.087)	(0.111)	(1,370)	(81)	(1,150)	(0.093)	(0.120)	(1,400)	(86)	(1,150)	(0.099)
RWD No. 2	(0.064)	(930)	(69)	(810)	(0.056)	(0.074)	(1,000)	(74)	(840)	(0.062)	(0.083)	(1,050)	(79)	(860)	(0.068)
Fallis (all individual wells)	0.002	50	49	50	0.002	0.003	50	54	50	0.002	0.003	50	59	50	0.003
Kendrick (all individual wells)	0.005	100	49	100	0.005	0.005	100	54	100	0.005	0.006	100	59	100	0.006
Meeker	0.318	2,530	125.8	2,200	0.277	0.373	2,850	130.8	2,400	0.314	0.430	3,170	135.8	2,600	0.353
Prague	1.150	4,610	249	4,010	0.998	1.310	5,150	254	4,340	1.100	1.470	5,680	259	4,660	1.210
Sparks (76% on individual wells with remaining 24% served by RWD No. 1) [5]	0.105	2,140	49	1,860	0.091	0.146	2,710	54	2,280	0.123	0.194	3,290	59	2,700	0.159
Stroud	0.658	5,770	114	5,020	0.572	0.737	6,190	119	5,220	0.621	0.818	6,600	124	5,410	0.671
Tryon	0.081	1,000	81	870	0.070	0.099	1,150	86	960	0.083	0.116	1,280	91	1,050	0.096
Warwick (all individual wells)	0.015	300	49	270	0.013	0.017	320	54	270	0.015	0.019	320	59	270	0.016
Wellston	0.131	1,100	119	960	0.114	0.141	1,140	124	960	0.119	0.151	1,170	129	960	0.124
RWD No. 1 (includes 24% of Sparks)	0.061	650	94	570	0.054	0.069	700	99	590	0.058	0.077	740	104	600	0.062
County Total	3.466	25,570		22,290	3.015	3.952	28,310		23,860	3.325	4.449	30,940		25,390	3.653

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[1] Source: Corps of Engineers, data sheets, December 1984.
[2] Big Creek RWC is reported in Pawnee County under Tri-County Development Authority, which will be its water supply source.
[3] SEDIP = Successful Economic Development Initiative Plans.
[4] OESC = Oklahoma Employment Security Commission.
[5] Corps' data modified to show that about 76 percent of Sparks is served by individual wells with the remainder included in RWD No. 1.

Table IX-12

Detailed Comparative Water Demand Projections for Okfuskee County 1/

(East-Central Oklahoma Water Supply Study, January 1985)

Okfuskee County 2/ Water User Entity	Year 1990					Year 2000					Year 2010				
	SEDIP 3/ Projections		Gallons Per Capita Per Day	OESC 4/ Projections		SEDIP Projections		Gallons Per Capita Per Day	OESC Projections		SEDIP Projections		Gallons Per Capita Per Day	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)
Okemah (supplies RWD Nos. 2 & 3 and Seminole County RW&SWMD No. 3) 5/	0.803	8,540	94	8,130	0.764	0.905	8,990	100.7	7,640	0.769	1.044	9,850	106	7,550	0.800
RWD No. 2 (serves Castle)	(0.115)	(1,550)	(74)	(1,460)	(0.108)	(0.092)	(1,160)	(79)	(970)	(0.077)	(0.106)	(1,260)	(84)	(970)	(0.081)
Castle	[0.009]	[160]	[56.2]	[150]	[0.008]	[0.007]	[120]	[61.2]	[100]	[0.006]	[0.009]	[130]	[66.2]	[100]	[0.007]
RWD No. 3 (includes Clearview & Pharoah)	(0.118)	(1,210)	(97.2)	(1,140)	(0.111)	(0.115)	(1,130)	(102.2)	(950)	(0.097)	(0.110)	(1,030)	(107.2)	(780)	(0.084)
Seminole RW&SWMD No. 3 (serves Cromwell)	(0.062)	(850)	(73.5)	(900)	(0.066)	(0.070)	(890)	(78.5)	(840)	(0.066)	(0.078)	(930)	(83.5)	(800)	(0.067)
Cromwell	[0.018]	[330]	[54]	[350]	[0.018]	[0.022]	[370]	[59]	[350]	[0.021]	[0.026]	[410]	[64]	[350]	[0.022]
Paden	0.037	540	68	500	0.034	0.044	600	73	500	0.037	0.052	670	78	500	0.039
Weleetka	0.204	1,850	110.1	1,750	0.193	0.229	1,990	115.1	1,670	0.192	0.243	2,020	120.1	1,520	0.183
RWD No. 1 (serves Boley)	0.022	490	44	450	0.020	0.020	410	49	340	0.017	0.021	380	54	280	0.015
Boley	(0.019)	(430)	(44.7)	(400)	(0.018)	(0.018)	(360)	(49.7)	(300)	(0.015)	(0.018)	(330)	(54.7)	(250)	(0.014)
County Total	1.066	11,420		10,830	1.011	1.198	11,990		10,150	1.015	1.360	12,920		9,850	1.037

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ No data reported for Okfuskee County portion of service area for Salem RWC (Okmulgee County). Includes data for Seminole County RW&SWMD No. 3 & town of Cromwell, which is not included in Seminole County.
3/ SEDIP = Successful Economic Development Initiative Plans.
4/ OESC = Oklahoma Employment Security Commission.
5/ Corps' data modified to include RWD No. 2 (including Castle), RWD No. 3 (including Clearview and Praroah), and Seminole County RW&SWMD No. 3 (including Cromwell) in Okemah totals.

Table IX-12 (Continued)

Detailed Comparative Water Demand Projections for Okfuskee County[1]

(East-Central Oklahoma Water Supply Study, January 1985)

Okfuskee County[2] Water User Entity	Year 2020					Year 2030					Year 2040				
	SEDIP[3] Projections		Gallons	OESC[4] Projections		SEDIP Projections		Gallons	OESC Projections		SEDIP Projections		Gallons	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)
Okemah (supplies RWD Nos. 2 & 3 and Seminole County RW&SWMD No. 3)[5]	1.230	11,060	111.2	7,440	0.827	1.423	12,200	116.6	7,150	0.834	1.635	13,480	121.3	6,890	0.836
RWD No. 2 (serves Castle)	(0.130)	(1,460)	(89)	(970)	(0.086)	(0.155)	(1,650)	(94)	(970)	(0.091)	(0.192)	(1,940)	(99)	(970)	(0.096)
Castle	[0.011]	[150]	[71.2]	[100]	[0.007]	[0.012]	[170]	[76.2]	[100]	[0.008]	[0.016]	[200]	[81.2]	[100]	[0.008]
RWD No. 3 (includes Clearview & Pharoah)	(0.103)	(920)	(112.2)	(610)	(0.068)	(0.086)	(730)	(117.2)	(420)	(0.049)	(0.061)	(500)	(122.2)	(250)	(0.031)
Seminole RW&SWMD No. 3 (serves Cromwell)	(0.085)	(960)	(88.5)	(730)	(0.065)	(0.089)	(950)	(93.5)	(630)	(0.059)	(0.092)	(930)	(98.5)	(540)	(0.053)
Cromwell	[0.032]	[460]	[69]	[350]	[0.024]	[0.039]	[530]	[74]	[350]	[0.026]	[0.048]	[610]	[79]	[350]	[0.028]
Paden	0.056	670	83	450	0.037	0.068	770	88	450	0.040	0.082	880	93	450	0.042
Weleetka	0.243	1,940	125.1	1,290	0.161	0.256	1,970	130.1	1,140	0.148	0.282	2,090	135.1	1,060	0.143
RWD No. 1 (serves Boley)	0.020	340	59	230	0.014	0.026	400	64	230	0.015	0.030	440	69	230	0.016
Boley	(0.018)	(300)	(59.7)	(200)	(0.012)	(0.023)	(350)	(64.7)	(200)	(0.013)	(0.027)	(390)	(69.7)	(200)	(0.014)
County Total	1.549	14,010		9,410	1.039	1.773	15,340		8,970	1.037	2.029	16,890		8,630	1.037

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[1] Source: Corps of Engineers, data sheets, December 1984.

[2] No data reported for Okfuskee County portion of service area for Salem RWC (Okmulgee County). Includes data for Seminole County RW&SWMD No. 3 & town of Cromwell, which is not included in Seminole County.

[3] SEDIP = Successful Economic Development Initiative Plans.

[4] OESC = Oklahoma Employment Security Commission.

[5] Corps' data modified to include RWD No. 2 (including Castle), RWD No. 3 (including Clearview and Praroah), and Seminole County RW&SWMD No. 3 (including Cromwell) in Okemah totals.

Table IX-13

Detailed Comparative Water Demand Projections for Pawnee County 1/
(East-Central Oklahoma Water Supply Study, January 1985, Rev. 2/85)

Pawnee County 2/ Water User Entity	Year 1990					Year 2000					Year 2010				
	SEDIP 3/ Projections		Gallons	OESC 4/ Projections		SEDIP Projections		Gallons	OESC Projections		SEDIP Projections		Gallons	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)
Cleveland (supplies RWD No. 2)	0.395	4,160	95	3,860	0.367	0.466	4,660	100	4,090	0.409	0.531	5,060	105	4,320	0.454
RWD No. 2 (includes Terlton)	(0.094)	(1,100)	(85)	(1,020)	(0.087)	(0.122)	(1,360)	(90)	(1,200)	(0.108)	(0.152)	(1,600)	(95)	(1,370)	(0.130)
Hallett	0.035	380	93.3	350	0.033	0.038	390	98.3	350	0.034	0.051	490	103.3	420	0.043
Jennings	0.021	380	55.4	350	0.019	0.024	400	60.4	350	0.021	0.027	410	65.4	350	0.023
Pawnee (also buying supplemental supply from Tri-County Development Authority) 5/	0.212	1,310	162	1,210	0.196	0.194	1,160	167	1,020	0.170	0.174	1,010	172	860	0.148
Ralston (supplies Ralston RWC)	0.042	590	70.7	550	0.039	0.048	630	75.7	550	0.042	0.052	640	80.7	550	0.044
Ralston RWC	(0.028)	(160)	(172)	(150)	(0.026)	(0.037)	(210)	(177)	(180)	(0.032)	(0.046)	(250)	(182)	(220)	(0.040)
Westport	0.023	380	60.6	350	0.021	0.033	510	65.6	450	0.030	0.045	640	70.6	550	0.039
RWD No. 1	0.131	2,380	55.1	2,210	0.122	0.183	3,050	60.1	2,680	0.161	0.240	3,680	65.1	3,150	0.205
RWD No. 2, Inc. (supplied by Mannford in Creek County) 6/	((0.042))	((590))	((70.7))	((550))	((0.039))	((0.058))	((760))	((75.7))	((660))	((0.050))	((0.073))	((910))	((80.7))	((780))	((0.063))
Tri-County Development Authority (supplies 9 entities listed below) 7/	1.054	11,252	94	10,771	1.007	1.233	12,768	97	11,504	1.111	1.407	14,047	100	12,060	1.206
Glencoe 8/	(0.048)	(640)	(75.2)	(610)	(0.046)	(0.067)	(840)	(80.2)	(760)	(0.061)	(0.086)	(1,010)	(85.2)	(860)	(0.073)
Pawnee (supplemental supply only) 5/	(0.204)	(1,260)	(162)	(1,170)	(0.190)	(0.185)	(1,110)	(167)	(980)	(0.164)	(0.167)	(970)	(172)	(830)	(0.143)
Yale 8/	(0.227)	(2,100)	(108)	(2,010)	(0.217)	(0.280)	(2,460)	(114)	(2,220)	(0.253)	(0.330)	(2,770)	(119)	(2,380)	(0.283)
Big Creek RWC (includes Agra) 9/	(0.199)	(2,235)	(89)	(2,235)	(0.199)	(0.238)	(2,530)	(94.0)	(2,530)	(0.238)	(0.279)	(2,815)	(99)	(2,815)	(0.279)
Blackburn-Skedee RWC	(0.046)	(1,040)	(44)	(990)	(0.044)	(0.063)	(1,280)	(49)	(1,160)	(0.057)	(0.079)	(1,460)	(54)	(1,270)	(0.069)
Blackburn	[0.003]	[110]	[29]	[100]	[0.003]	[0.004]	[110]	[34]	[100]	[0.003]	[0.005]	[120]	[39]	[100]	[0.004]
Skedee	[0.006]	[110]	[55.3]	[100]	[0.006]	[0.007]	[110]	[60.3]	[100]	[0.006]	[0.004]	[60]	[65.3]	[50]	[0.003]
51 East Water, Inc. 8/	(0.113)	(1,370)	(82.3)	(1,300)	(0.107)	(0.132)	(1,510)	(87.3)	(1,360)	(0.119)	(0.150)	(1,620)	(92.3)	(1,390)	(0.128)
Morr Water Co., Inc. 10/	(0.122)	(1,337)	(91)	(1,256)	(0.114)	(0.146)	(1,518)	(96)	(1,154)	(0.111)	(0.170)	(1,682)	(101)	(1,035)	(0.105)
Pawnee County RWD No. 3 11/	(0.044)	(590)	(75.1)	(550)	(0.041)	(0.061)	(760)	(80.1)	(660)	(0.053)	(0.077)	(910)	(85.1)	(780)	(0.066)
Yale RWC (includes Maramec and Quay) 12/	(0.051)	(680)	(75.7)	(650)	(0.049)	(0.061)	(760)	(80.7)	(680)	(0.055)	(0.069)	(810)	(85.7)	(700)	(0.060)
Maramec	[0.006]	[110]	[53.5]	[100]	[0.005]	[0.004]	[60]	[58.5]	[50]	[0.003]	[0.004]	[60]	[63.5]	[50]	[0.003]
Quay	[0.003]	[50]	[64]	[50]	[0.003]	[0.004]	[60]	[69]	[50]	[0.003]	[0.004]	[60]	[74]	[50]	[0.003]
County Total	1.913	20,832		19,651	1.804	2.219	23,568		20,994	1.978	2.527	25,977		22,260	2.162

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ Includes entities serving in Lincoln, Noble, and Payne Counties, where water supply source is Tri-County Development Authority in Pawnee County.
3/ SEDIP = Successful Economic Development Initiative Plans.
4/ OESC = Oklahoma Employment Security Commission.
5/ Will purchase "50 percent or less" supplemental supply from Tri-County Development Authority. For projection purposes, will assume 51 percent self-supplied and 49 percent supplemental supply.
6/ Supplied by Mannford in Creek County. Not included in county totals.
7/ Has no service population of its own other than a few families near Lake Lone Chimney and water treatment plant. Supplies treated water to member entities. Corps' data modified to include this new development which should go into service in very late 1985 or early 1986.
8/ Supply source in Pawnee County, but entire service area is in Payne County.
9/ Supply source in Pawnee County, but service area is in Lincoln and Payne Counties.
10/ Supply source in Pawnee County, but service area is in Noble County plus several sections in Payne County.
11/ Includes an area served in Payne County.
12/ Supply source in Pawnee County. Primary service area is in Payne County but also serves rural area and municipalities of Maramec and Quay in Pawnee County.

Table IX-13 (Continued)
Detailed Comparative Water Demand Projections for Pawnee County 1/
(East-Central Oklahoma Water Supply Study, January 1985, Rev. 2/85)

Pawnee County 2/ Water User Entity	Year 2020					Year 2030					Year 2040				
	SEDIP 3/ Projections		Gallons	OESC 4/ Projections		SEDIP Projections		Gallons	OESC Projections		SEDIP Projections		Gallons	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)
Cleveland (supplies RWD No. 2)	0.581	5,280	110	4,440	0.488	0.635	5,520	115	4,560	0.524	0.691	5,760	120	4,670	0.560
RWD No. 2 (includes Terlton)	(0.188)	(1,880)	(100)	(1,580)	(0.158)	(0.219)	(2,090)	(105)	(1,720)	(0.181)	(0.251)	(2,280)	(110)	(1,850)	(0.204)
Hallett	0.064	590	108.3	490	0.053	0.067	590	113.3	490	0.056	0.072	610	118.3	490	0.058
Jennings	0.025	360	70.4	300	0.021	0.027	360	75.4	300	0.023	0.030	370	80.4	300	0.024
Pawnee (also buying supplemental supply from Tri-County Development Authority) 5/	0.149	840	177	700	0.124	0.122	670	182	550	0.100	0.092	490	187	390	0.073
Ralston (supplies Ralston RWC)	0.056	650	85.7	550	0.047	0.061	670	90.7	550	0.049	0.065	680	95.7	550	0.053
Ralston RWC	(0.054)	(290)	(187)	(250)	(0.047)	(0.063)	(330)	(192)	(270)	(0.052)	(0.071)	(360)	(197)	(300)	(0.059)
Westport	0.058	770	75.6	650	0.049	0.073	910	80.6	750	0.060	0.090	1,050	85.6	850	0.073
RWD No. 1	0.299	4,270	70.1	3,590	0.252	0.361	4,810	75.1	3,970	0.298	0.425	5,300	80.1	4,300	0.344
RWD No. 2, Inc. (supplied by Mannford in Creek County) 6/	((0.090))	((1,050))	((85.7))	((890))	((0.076))	((0.108))	((1,190))	((90.7))	((980))	((0.089))	((0.125))	((1,310))	((95.7))	((1,060))	((0.101))
Tri-County Development Authority (supplies 9 entities listed below) 7/	1.571	15,129	104	12,409	1.285	1.724	16,006	107	12,546	1.346	1.877	16,795	111	12,644	1.403
Glencoe 8/	(0.107)	(1,190)	(90.2)	(960)	(0.087)	(0.132)	(1,390)	(95.2)	(1,070)	(0.102)	(0.160)	(1,600)	(100.2)	(1,170)	(0.117)
Pawnee (supplemental supply only) 5/	(0.143)	(810)	(177)	(680)	(0.120)	(0.116)	(640)	(182)	(530)	(0.096)	(0.088)	(470)	(187)	(380)	(0.071)
Yale 8/	(0.382)	(3,060)	(125)	(2,490)	(0.311)	(0.432)	(3,320)	(130)	(2,540)	(0.330)	(0.484)	(3,560)	(136)	(2,590)	(0.352)
Big Creek RWC (includes Agra) 9/	(0.314)	(3,020)	(104)	(3,020)	(0.314)	(0.343)	(3,145)	(109)	(3,145)	(0.343)	(0.372)	(3,265)	(114)	(3,265)	(0.372)
Blackburn-Skedee RWC	(0.098)	(1,660)	(59)	(1,430)	(0.084)	(0.118)	(1,840)	(64)	(1,570)	(0.100)	(0.139)	(2,020)	(69)	(1,690)	(0.117)
Blackburn	[0.005]	[120]	[44]	[100]	[0.004]	[0.006]	[120]	[49]	[100]	[0.005]	[0.006]	[120]	[54]	[100]	[0.005]
Skedee	[0.004]	[60]	[70.3]	[50]	[0.004]	[0.005]	[60]	[75.3]	[50]	[0.004]	[0.005]	[60]	[80.3]	[50]	[0.004]
51 East Water, Inc. 8/	(0.162)	(1,670)	(97.3)	(1,360)	(0.132)	(0.172)	(1,680)	(102.3)	(1,290)	(0.132)	(0.178)	(1,660)	(107.3)	(1,210)	(0.130)
Morr Water Co., Inc. 10/	(0.194)	(1,829)	(106)	(899)	(0.095)	(0.218)	(1,961)	(111)	(781)	(0.087)	(0.241)	(2,080)	(116)	(679)	(0.078)
Pawnee County RWD No. 3 11/	(0.095)	(1,050)	(90.1)	(890)	(0.080)	(0.113)	(1,190)	(95.1)	(980)	(0.093)	(0.131)	(1,310)	(100.1)	(1,060)	(0.106)
Yale RWC (includes Maramec and Quay) 12/	(0.076)	(840)	(90.7)	(680)	(0.062)	(0.080)	(840)	(95.7)	(640)	(0.061)	(0.084)	(830)	(100.7)	(600)	(0.060)
Maramec	[0.004]	[60]	[68.5]	[50]	[0.003]	[0.004]	[60]	[73.5]	[50]	[0.004]	[0.005]	[60]	[78.5]	[50]	[0.004]
Quay	[0.047]	[60]	[79]	[50]	[0.004]	[0.005]	[60]	[84]	[50]	[0.004]	[0.005]	[60]	[89]	[50]	[0.004]
County Total	2.803	27,889		23,129	2.319	3.070	29,536		23,716	2.456	3.342	31,055		24,194	2.588

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ Includes entities serving in Lincoln, Noble, and Payne Counties, where water supply source is Tri-County Development Authority in Pawnee County.
3/ SEDIP = Successful Economic Development Initiative Plans.
4/ OESC = Oklahoma Employment Security Commission.
5/ Will purchase "50 percent or less" supplemental supply from Tri-County Development Authority. For projection purposes, will assume 51 percent self-supplied and 49 percent supplemental supply.
6/ Supplied by Mannford in Creek County. Not included in county totals.
7/ Has no service population of its own other than a few families near Lake Lone Chimney and water treatment plant. Supplies treated water to member entities. Corps' data modified to include this new development which should go into service in very late 1985 or early 1986.
8/ Supply source in Pawnee County, but entire service area is in Payne County.
9/ Supply source in Pawnee County, but service area is in Lincoln and Payne Counties.
10/ Supply source in Pawnee County, but service area is in Noble County plus several sections in Payne County.
11/ Includes an area served in Payne County.
12/ Supply source in Pawnee County. Primary service area is in Payne County but also serves rural area and municipalities of Maramec and Quay in Pawnee County.

Table IX-14

Detailed Comparative Water Demand Projections for Payne County 1/

(East-Central Oklahoma Water Supply Study, January 1985, Rev. 2/85)

Payne County 2/ Water User Entity	Year 1990					Year 2000					Year 2010				
	SEDIP 3/ Projections		Gallons	OESC 4/ Projections		SEDIP Projections		Gallons	OESC Projections		SEDIP Projections		Gallons	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)
Cushing	1.323	9,190	144	8,760	1.261	1.432	9,610	149	8,650	1.289	1.512	9,820	154	8,430	1.298
Perkins	0.207	2,760	75	2,630	0.197	0.288	3,600	80	3,240	0.259	0.399	4,690	85	4,020	0.342
Ripley	0.044	580	75.1	550	0.041	0.058	720	80.1	650	0.052	0.079	930	85.1	800	0.068
Stillwater (supplies RWD No. 1 and RWC No. 3) 5/	7.478	48,560	154	46,260	7.124	8.921	56,110	159	50,480	8.026	10.330	62,990	164	54,050	8.864
RWD No. 1	(0.037)	(540)	(67.8)	(510)	(0.035)	(0.043)	(590)	(72.8)	(530)	(0.039)	(0.049)	(630)	(77.8)	(540)	(0.042)
RWC No. 3	(0.117)	(1,490)	(78.7)	(710)	(0.056)	(0.139)	(1,660)	(83.7)	(1,490)	(0.125)	(0.157)	(1,770)	(38.7)	(1,520)	(0.135)
RWD No. 3	0.075	740	100.9	1,420	0.143	0.087	820	105.9	740	0.078	0.098	880	110.9	750	0.083
County Totals	9.127	61,830		59,620	8.766	10.786	70,860		63,760	9.704	12.418	79,310		68,050	10.655

1/ Source: Corps of Engineers, data sheets, December 1984.

2/ No data included for small areas served by Morr Water, Inc., (Noble County) and RWD No. 3 (Pawnee County). Area served by Big Creek RWC reported under Pawnee County. Municipalities of Glencoe and Yale as well as 51 East Water Co., Inc., and Yale RWC are reported in Pawnee County under Tri-County Development Authority, which will be their water supply source.

3/ SEDIP = Successful Economic Development Initiative Plans.

4/ OESC = Oklahoma Employment Security Commission.

5/ Corps' data modified to include RWD No. 1 and RWC No. 3 in Stillwater totals.

Table IX-14 (Continued)
Detailed Comparative Water Demand Projections for Payne County 1/
(East-Central Oklahoma Water Supply Study, January 1985, Rev. 2/85)

Payne County 2/ Water User Entity	Year 2020					Year 2030					Year 2040				
	SEDIP 3/ Projections		Gallons	OESC 4/ Projections		SEDIP Projections		Gallons	OESC Projections		SEDIP Projections		Gallons	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)
Cushing	1.604	10,090	159	8,210	1.305	1.711	10,430	164	7,980	1.309	1.807	10,690	169	7,760	1.311
Perkins	0.532	5,910	90	4,800	0.043	0.693	7,290	95	5,590	0.531	0.877	8,770	100	6,370	0.637
Ripley	0.100	1,110	90.1	900	0.081	0.125	1,310	95.1	1,000	0.095	0.151	1,510	100.1	1,100	0.110
Stillwater (supplies RWD No. 1 and RWC No. 3) 5/	11.700	69,230	169	56,320	9.518	13.066	74,660	175	57,120	9.996	14.350	79,720	180	57,910	10.424
RWD No. 1	(0.054)	(650)	(82.8)	(530)	(0.044)	(0.579)	(660)	(87.8)	(500)	(0.044)	(0.060)	(650)	(92.8)	(470)	(0.044)
RWC No. 3	(0.171)	(1,830)	(93.7)	(1,490)	(0.140)	(0.182)	(1,840)	(98.7)	(1,410)	(0.139)	(0.188)	(1,810)	(103.7)	(1,320)	(0.137)
RWD No. 3	0.105	910	115.9	740	0.086	0.110	910	120.9	700	0.085	0.113	900	125.9	650	0.082
County Totals	14.041	87,250		70,970	11.033	15.705	94,600		72,390	12.016	17.298	101,590		73,790	12.564

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ No data included for small areas served by Morr Water, Inc., (Noble County) and RWD No. 3 (Pawnee County). Area served by Big Creek RWC reported under Pawnee County. Municipalities of Glencoe and Yale as well as 51 East Water Co., Inc., and Yale RWC are reported in Pawnee County under Tri-County Development Authority, which will be their water supply source.
3/ SEDIP = Successful Economic Development Initiative Plans.
4/ OESC = Oklahoma Employment Security Commission.
5/ Corps' data modified to include RWD No. 1 and RWC No. 3 in Stillwater totals.

Table IX-15
Detailed Comparative Water Demand Projections for Pontotoc County 1/
(East-Central Oklahoma Water Supply Study, January 1985)

Pontotoc County 2/ Water User Entity	Year 1990					Year 2000					Year 2010				
	SEDIP 3/ Projections		Gallons Per Capita Per Day	OESC 4/ Projections		SEDIP Projections		Gallons Per Capita Per Day	OESC Projections		SEDIP Projections		Gallons Per Capita Per Day	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served		Population Served	Average Daily Use (Mgal/d)
Ada PWA (includes Anloso and Latta plus supplies Byng and eight rural water districts)	5.515	28,270	195.1	26,680	5.205	6.293	31,450	200.1	27,440	5.491	7.041	34,330	205.1	27,890	5.720
Byng	(0.100)	(1,270)	(79)	(1,200)	(0.095)	(0.154)	(1,830)	(84.0)	(1,600)	(0.134)	(0.219)	(2,460)	(89.0)	(2,000)	(0.178)
RWD No. 1	(0.057)	(650)	(88.1)	(610)	(0.054)	(0.065)	(700)	(93.1)	(610)	(0.057)	(0.074)	(750)	(98.1)	(610)	(0.060)
RWD No. 2	(0.218)	(2,330)	(93.6)	(2,200)	(0.206)	(0.249)	(2,530)	(98.6)	(2,210)	(0.218)	(0.280)	(2,700)	(103.6)	(2,190)	(0.227)
RWD No. 3	(0.172)	(2,060)	(83.7)	(1,940)	(0.162)	(0.199)	(2,240)	(88.7)	(1,950)	(0.173)	(0.224)	(2,390)	(93.7)	(1,940)	(0.182)
RWD No. 4	(0.062)	(280)	(220.4)	(270)	(0.060)	(0.070)	(310)	(225.4)	(270)	(0.061)	(0.076)	(330)	(230.4)	(260)	(0.060)
RWD No. 5	(0.015)	(180)	(83.4)	(170)	(0.014)	(0.017)	(190)	(88.4)	(170)	(0.015)	(0.020)	(210)	(93.4)	(170)	(0.016)
RWD No. 6 (includes Fittstown, Jesse, and Harden City)	(0.086)	(900)	(96)	(850)	(0.082)	(0.099)	(980)	(101.0)	(850)	(0.086)	(0.110)	(1,040)	(106.0)	(850)	(0.090)
RWD No. 7	(0.108)	(900)	(119.9)	(850)	(0.102)	(0.122)	(980)	(124.9)	(850)	(0.106)	(0.135)	(1,040)	(129.9)	(850)	(0.110)
RWD No. 8	(0.180)	(1,690)	(106.7)	(1,590)	(0.170)	(0.204)	(1,830)	(111.7)	(1,600)	(0.179)	(0.228)	(1,950)	(116.7)	(1,590)	(0.186)
Allen PWA 5/	0.182	1,250	145.6	1,190	0.173	0.193	1,280	150.6	1,120	0.169	0.201	1,290	155.6	1,050	0.163
Francis	0.070	470	148.5	450	0.067	0.091	590	153.5	510	0.078	0.111	700	158.5	560	0.089
Roff	0.136	920	147.8	860	0.127	0.159	1,040	152.8	920	0.141	0.178	1,130	157.8	920	0.145
Stonewall PWA	0.093	820	113.6	770	0.087	0.104	880	118.6	770	0.091	0.117	950	123.6	770	0.095
County Totals	5.996	31,730		29,950	5.659	6.840	35,240		30,760	5.970	7.648	38,400		31,190	6.212

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ No data included for small areas served by RWD No. 1 (Garvin County) and RWD No. 1 (Murray County).
3/ SEDIP = Successful Economic Development Initiative Plans.
4/ OESC = Oklahoma Employment Security Commission.
5/ Includes data for small area served in Hughes County.

Table IX-15 (Continued)

Detailed Comparative Water Demand Projections for Pontotoc County [1]

(East-Central Oklahoma Water Supply Study, January 1985)

Pontotoc County [2] Water User Entity	Year 2020					Year 2030					Year 2040				
	SEDIP [3] Projections		Gallons	OESC [4] Projections		SEDIP Projections		Gallons	OESC Projections		SEDIP Projections		Gallons	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)
Ada PWA (includes Anloso and Latta plus supplies Byng and eight rural water districts)	7.755	36,910	210.1	27,660	5.811	8.445	39,260	215.1	26,750	5.754	9.108	41,380	220.1	25,920	5.705
Byng	(0.301)	(3,200)	(94.0)	(2,400)	(0.226)	(0.378)	(3,820)	(99.0)	(2,600)	(0.257)	(0.465)	(4,470)	(104.0)	(2,800)	(0.291)
RWD No. 1	(0.078)	(760)	(103.1)	(570)	(0.059)	(0.080)	(740)	(108.1)	(500)	(0.054)	(0.079)	(700)	(113.1)	(440)	(0.050)
RWD No. 2	(0.299)	(2,750)	(108.6)	(2,060)	(0.224)	(0.303)	(2,670)	(113.6)	(1,820)	(0.207)	(0.302)	(2,550)	(118.6)	(1,600)	(0.190)
RWD No. 3	(0.240)	(2,430)	(98.7)	(1,820)	(0.180)	(0.245)	(2,360)	(103.7)	(1,610)	(0.167)	(0.245)	(2,250)	(108.7)	(1,410)	(0.153)
RWD No. 4	(0.078)	(330)	(235.4)	(250)	(0.059)	(0.077)	(320)	(240.4)	(220)	(0.053)	(0.076)	(310)	(245.4)	(190)	(0.047)
RWD No. 5	(0.021)	(210)	(98.4)	(160)	(0.016)	(0.021)	(200)	(103.4)	(140)	(0.014)	(0.021)	(190)	(108.4)	(120)	(0.013)
RWD No. 6 (includes Fittstown, Jesse, and Harden City)	(0.118)	(1,060)	(111.0)	(790)	(0.088)	(0.119)	(1,030)	(116.0)	(700)	(0.081)	(0.119)	(980)	(121.0)	(620)	(0.075)
RWD No. 7	(0.143)	(1,060)	(134.9)	(790)	(0.107)	(0.144)	(1,030)	(139.9)	(700)	(0.098)	(0.142)	(980)	(144.9)	(620)	(0.090)
RWD No. 8	(0.242)	(1,990)	(121.7)	(1,490)	(0.081)	(0.245)	(1,930)	(126.7)	(1,320)	(0.167)	(0.242)	(1,840)	(131.7)	(1,150)	(0.151)
Allen PWA [5]	0.212	1,320	160.6	990	0.159	0.240	1,450	165.6	990	0.164	0.270	1,580	170.6	990	0.169
Francis	0.134	820	163.5	620	0.101	0.169	990	168.5	680	0.115	0.203	1,170	173.5	730	0.127
Roff	0.210	1,290	162.8	970	0.158	0.238	1,420	167.8	970	0.163	0.268	1,550	172.8	970	0.168
Stonewall PWA	0.132	1,030	128.6	770	0.099	0.152	1,140	133.6	770	0.103	0.172	1,240	138.6	770	0.107
County Totals	8.443	41,370		31,010	6.328	9.244	44,260		30,160	6.299	10.021	46,920		29,380	6.276

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[1] Source: Corps of Engineers, data sheets, December 1984.

[2] No data included for small areas served by RWD No. 1 (Garvin County) and RWD No. 1 (Murray County).

[3] SEDIP = Successful Economic Development Initiative Plans.

[4] OESC = Oklahoma Employment Security Commission.

[5] Includes data for small area served in Hughes County.

Table IX-16

Detailed Comparative Water Demand Projections for Pottawatomie County 1/

(East-Central Oklahoma Water Supply Study, January 1985)

Pottawatomie County Water User Entity	Year 1990					Year 2000					Year 2010				
	SEDIP 2/ Projections		Gallons	OESC 3/ Projections		SEDIP Projections		Gallons	OESC Projections		SEDIP Projections		Gallons	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)
Asher	0.031	590	52.9	550	0.029	0.045	770	57.9	680	0.039	0.064	1,010	62.9	840	0.053
Bethel Acres (56.8% assumed to be individual wells) 4/	0.093	1,715	54.1	1,607	0.087	0.134	2,266	59.1	1,982	0.117	0.186	2,902	64.1	2,414	0.155
Brooksville (individual wells)	0.002	50	34	50	0.002	0.002	60	39	50	0.002	0.003	60	44	50	0.002
McLoud	0.145	1,510	95.7	1,410	0.136	0.191	1,900	100.7	1,670	0.168	0.244	2,310	105.7	1,920	0.203
Macomb (individual wells)	0.002	50	39.7	50	0.002	0.003	60	44.7	50	0.002	0.003	60	49.7	50	0.002
Maud 5/	0.199	1,810	109.8	1,690	0.186	0.232	2,020	114.8	1,760	0.202	0.264	2,200	119.8	1,830	0.219
Pink (individual wells)	0.042	1,170	35.6	1,100	0.039	0.060	1,480	40.6	1,300	0.053	0.082	1,800	45.6	1,500	0.068
Remus (individual wells) 6/	0.006	160	35.5	150	0.005	0.007	170	40.5	150	0.006	0.008	180	45.5	150	0.007
Shawnee (total M&I)	4.200				3.960	4.916				4.360	5.547				4.702
Municipal Use (supplies Bethel Acres RWD No. 1) 7/	(3.871)	(28,680)	(135)	(26,890)	(3.630)	(4.490)	(32,040)	(140)	(28,070)	(3.930)	(5.017)	(34,600)	(145)	(28,770)	(4.172)
Bethel Acres RWD No. 1 (includes 43.2% of Bethel Acres)	[0.074]	[1,190]	[62]	[1,120]	[0.069]	[0.094]	[1,400]	[67]	[1,230]	[0.082]	[0.114]	[1,580]	[72]	[1,310]	[0.094]
Industrial Use	(0.330)				(0.330)	(0.430)				(0.430)	(0.530)				(0.530)
SIC 30	[0.190]				[0.190]	[0.240]				[0.240]	[0.290]				[0.290]
SIC 32	[0.140]				[0.140]	[0.190]				[0.190]	[0.240]				[0.240]
Tecumseh	0.678	6,460	104.9	6,060	0.636	0.835	7,600	109.9	6,660	0.732	1.004	8,740	114.9	7,270	0.835
Tribbey (individual wells)	0.010	270	35.5	250	0.009	0.012	290	40.5	250	0.010	0.012	240	45.5	200	0.009
Wanette	0.039	590	65.5	550	0.036	0.044	630	70.5	550	0.039	0.054	720	75.5	600	0.045
Earlsboro Water Co. (supplies Earlsboro) 8/	0.253	2,940	86	2,750	0.237	0.312	3,430	91	3,000	0.273	0.368	3,830	96	3,190	0.306
Earlsboro	(0.014)	(270)	(53.4)	(250)	(0.013)	(0.017)	(290)	(58.4)	(250)	(0.015)	(0.019)	(300)	(63.4)	(250)	(0.016)
St. Louis Utility Authority (supplies St. Louis and includes Pearson)	0.018	330	54	310	0.017	0.022	370	59	330	0.019	0.030	470	64	390	0.025
St. Louis	(0.007)	(160)	(46.7)	(150)	(0.007)	(0.009)	(170)	(51.7)	(150)	(0.008)	(0.014)	(240)	(56.7)	(200)	(0.011)
County Totals	5.718	47,355		44,387	5.381	6.815	52,916		46,352	6.040	7.869	58,942		49,024	6.631

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ SEDIP = Successful Economic Development Initiative Plans.
3/ OESC = Oklahoma Employment Security Commission.
4/ Corps' data modified to assume 56.8% on individual wells with the remaining 43.2% included in Bethel Acres RWD No. 1.
5/ Data include part of municipal area in Seminole County.
6/ Data added for Remus. Remus missing from Corps' projections.
7/ Corps' data modified to include Bethel Acres RWD No. 1 in Shawnee municipal totals.
8/ Data include area served in Seminole County.

Table IX-16 (Continued)
Detailed Comparative Water Demand Projections for Pottawatomie County 1/
(East-Central Oklahoma Water Supply Study, January 1985)

Pottawatomie County Water User Entity	Year 2020 SEDIP 2/ Projections		Year 2020	Year 2020 OESC 3/ Projections		Year 2030 SEDIP Projections		Year 2030	Year 2030 OESC Projections		Year 2040 SEDIP Projections		Year 2040	Year 2040 OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Gallons Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Gallons Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Gallons Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)
Asher	0.084	1,230	67.9	970	0.066	0.108	1,480	72.9	1,100	0.080	0.136	1,750	77.9	1,230	0.096
Bethel Acres (56.8% assumed to be individual wells) 4/	0.244	3,538	69.1	2,788	0.193	0.323	4,362	74.1	3,214	0.238	0.412	5,208	79.1	3,646	0.288
Brooksville (individual wells)	0.003	60	49	50	0.002	0.004	70	54	50	0.003	0.004	70	59	50	0.003
McLoud	0.301	2,720	110.7	2,150	0.238	0.371	3,210	115.7	2,370	0.274	0.448	3,710	120.7	2,600	0.314
Macomb (individual wells)	0.003	60	54.7	50	0.003	0.004	70	59.7	50	0.003	0.005	70	64.7	50	0.003
Maud 5/	0.292	2,330	124.8	1,830	0.228	0.322	2,480	129.8	1,830	0.238	0.353	2,620	134.8	1,830	0.247
Pink (individual wells)	0.109	2,160	50.6	1,700	0.086	0.136	2,440	55.6	1,800	0.100	0.164	2,710	60.6	1,900	0.115
Remus (individual wells) 6/	0.010	190	50.5	150	0.008	0.011	200	55.5	150	0.008	0.013	210	60.5	150	0.009
Shawnee (total M&I)	6.209				5.027	6.955				5.326	7.718				5.665
Municipal Use (supplies Bethel Acres RWD No. 1) 7/	(5.579)	(37,190)	(150)	(29,310)	(4.397)	(6.224)	(40,160)	(155)	(29,650)	(4.596)	(6.848)	(42,800)	(160)	(29,970)	(4.795)
Bethel Acres RWD No. 1 (includes 43.2% of Bethel Acres)	[0.129]	[1,680]	[77]	[1,320]	[0.102]	[0.134]	[1,640]	[82]	[1,210]	[0.099]	[0.136]	[1,560]	[87]	[1,090]	[0.094]
Industrial Use	(0.630)				(0.630)	(0.730)				(0.730)	(0.870)				(0.870)
SIC 30	[0.330]				[0.330]	[0.370]				[0.370]	[0.430]				[0.430]
SIC 32	[0.300]				[0.300]	[0.360]				[0.360]	[0.440]				[0.440]
Tecumseh	1.183	9,870	119.9	7,780	0.933	1.350	10,810	124.9	7,980	0.997	1.517	11,680	129.9	8,180	1.063
Tribbey (individual wells)	0.013	250	50.5	200	0.010	0.015	270	55.5	200	0.011	0.018	290	60.5	200	0.012
Wanette	0.061	760	80.5	600	0.048	0.069	810	85.5	600	0.051	0.078	860	90.5	600	0.054
Earlsboro Water Co. (supplies Earlsboro) 8/	0.405	4,010	101	3,160	0.319	0.417	3,930	106	2,900	0.307	0.420	3,780	111	2,640	0.293
Earlsboro	(0.017)	(250)	(68.4)	(200)	(0.014)	(0.020)	(270)	(73.4)	(200)	(0.015)	(0.023)	(290)	(78.4)	(200)	(0.016)
St. Louis Utility Authority (supplies St. Louis and includes Pearson)	0.034	490	69	390	0.027	0.037	500	74	370	0.027	0.040	510	79	360	0.028
St. Louis	(0.015)	(250)	(61.7)	(200)	(0.012)	(0.018)	(270)	(66.7)	(200)	(0.013)	(0.021)	(290)	(71.7)	(200)	(0.014)
County Totals	8.951	64,668		50,978	7.188	10.133	70,592		52,114	7.663	11.326	76,058		53,256	8.190

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ SEDIP = Successful Economic Development Initiative Plans.
3/ OESC = Oklahoma Employment Security Commission.
4/ Corps' data modified to assume 56.8% on individual wells with the remaining 43.2% included in Bethel Acres RWD No. 1.
5/ Data include part of municipal area in Seminole County.
6/ Data added for Remus. Remus missing from Corps' projections.
7/ Corps' data modified to include Bethel Acres RWD No. 1 in Shawnee municipal totals.
8/ Data include area served in Seminole County.

Table IX-17

Detailed Comparative Water Demand Projections for Seminole County 1/

(East-Central Oklahoma Water Supply Study, January 1985)

Seminole County 2/ Water User Entity	Year 1990					Year 2000					Year 2010				
	SEDIP 3/ Projections		Gallons	OESC 4/ Projections		SEDIP Projections		Gallons	OESC Projections		SEDIP Projections		Gallons	OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)
Bowlegs (part not served by Bowlegs-Lima Water District)	0.015	440	35.1	470	0.016	0.020	490	40.1	470	0.019	0.025	550	45.1	470	0.021
Konawa	0.206	1,700	121.1	1,780	0.216	0.230	1,820	126.1	1,730	0.218	0.243	1,850	131.1	1,580	0.207
Sasakwa	0.019	430	44.7	460	0.021	0.024	480	49.7	460	0.023	0.030	540	54.7	460	0.025
Seminole	1.270	8,770	144.8	9,200	1.332	1.485	9,910	149.8	9,400	1.408	1.700	11,010	154.8	9,400	1.460
Wewoka (supplies RWD Nos. 1, 2, and 5) 5/	0.720	6,430	112	6,730	0.753	0.826	7,020	117.7	6,650	0.783	0.934	7,580	123.2	6,470	0.797
RWD No. 1	(0.018)	(370)	(49)	(390)	(0.019)	(0.020)	(370)	(54)	(350)	(0.019)	(0.022)	(370)	(59)	(320)	(0.019)
RWD No. 2	(0.029)	(390)	(73.4)	(400)	(0.029)	(0.031)	(390)	(78.4)	(370)	(0.029)	(0.033)	(390)	(83.4)	(330)	(0.028)
RWD No. 5	(0.017)	(140)	(124)	(140)	(0.017)	(0.018)	(140)	(129)	(130)	(0.017)	(0.019)	(140)	(134)	(120)	(0.134)
Bowlegs-Lima Water District (supplies Lima and includes part of Bowlegs)	0.144	1,620	88.9	1,690	0.150	0.152	1,620	93.9	1,530	0.144	0.161	1,630	98.9	1,390	0.137
Lima	(0.021)	(240)	(88.9)	(250)	(0.022)	(0.029)	(310)	(93.9)	(300)	(0.028)	(0.034)	(340)	(98.9)	(300)	(0.030)
Sasakwa RWD of the Seminole Nation	0.021	180	114	190	0.022	0.021	180	119	170	0.020	0.024	190	124	160	0.020
County Total	2.395	19,570		20,520	2.510	2.758	21,520		20,410	2.615	3.117	23,350		19,930	2.667

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ Data for areas served by Earlsboro Water Inc. and city of Maud are reported under Pottawatomie County. Data for area served by RW&SWMD No. 3 and town of Cromwell are reported under Okemah in Okfuskee County.
3/ SEDIP = Successful Economic Development Initiative Plans.
4/ OESC = Oklahoma Employment Security Commission.
5/ Corps' data modified to include RWD Nos. 1, 2, and 5 in Wewoka totals.

Table IX-17 (Continued)
Detailed Comparative Water Demand Projections for Seminole County 1/
(East-Central Oklahoma Water Supply Study, January 1985)

Seminole County 2/ Water User Entity	Year 2020					Year 2030					Year 2040				
	SEDIP 3/ Projections			OESC 4/ Projections		SEDIP Projections			OESC Projections		SEDIP Projections			OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Gallons Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Gallons Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Gallons Per Capita Per Day	Population Served	Average Daily Use (Mgal/d)
Bowlegs (part not served by Bowlegs-Lima Water District)	0.031	620	50.1	470	0.024	0.040	720	55.1	470	0.026	0.049	820	60.1	470	0.028
Konawa	0.265	1,950	136.1	1,480	0.201	0.285	2,020	141.1	1,320	0.186	0.301	2,060	146.1	1,170	0.171
Sasakwa	0.036	600	59.7	460	0.027	0.045	690	64.7	460	0.030	0.056	800	69.7	460	0.032
Seminole	1.940	12,150	159.8	9,200	1.470	2.260	13,720	164.8	9,000	1.480	2.620	15,420	169.8	8,800	1.490
Wewoka (supplies RWD Nos. 1, 2, and 5) 5/	1.050	8,130	128.7	6,150	0.791	1.200	8,950	135	5,880	0.794	1.390	9,850	141	5,620	0.792
RWD No. 1	(0.023)	(360)	(64)	(270)	(0.017)	(0.020)	(300)	(69)	(200)	(0.014)	(0.017)	(230)	(74)	(130)	(0.010)
RWD No. 2	(0.033)	(370)	(88.4)	(280)	(0.025)	(0.029)	(310)	(93.4)	(210)	(0.020)	(0.024)	(240)	(98.4)	(140)	(0.014)
RWD No. 5	(0.018)	(130)	(139)	(100)	(0.014)	(0.016)	(110)	(144)	(70)	(0.010)	(0.013)	(90)	(149)	(50)	(0.007)
Bowlegs-Lima Water District (supplies Lima and includes part of Bowlegs)	0.162	1,560	103.9	1,180	0.026	0.143	1,310	108.9	860	0.094	0.115	1,010	113.9	570	0.065
Lima	(0.033)	(320)	(103.9)	(250)	(0.026)	(0.040)	(370)	(108.9)	(250)	(0.027)	(0.050)	(430)	(113.9)	(250)	(0.028)
Sasakwa RWD of the Seminole Nation	0.023	180	129	130	0.017	0.020	150	134	100	0.013	0.015	110	139	70	0.010
County Total	3.507	25,190		19,070	2.556	3.993	27,560		18,090	2.623	4.546	30,070		17,160	2.588

1/ Source: Corps of Engineers, data sheets, December 1984.
2/ Data for areas served by Earlsboro Water Inc. and city of Maud are reported under Pottawatomie County. Data for area served by RW&SWMD No. 3 and town of Cromwell are reported under Okemah in Okfuskee County.
3/ SEDIP = Successful Economic Development Initiative Plans.
4/ OESC = Oklahoma Employment Security Commission.
5/ Corps' data modified to include RWD Nos. 1, 2, and 5 in Wewoka totals.

Table IX-18

Summary of Comparative Water Demand Projections for Study Area [1]

(East-Central Oklahoma Water Supply Study, January 1985)

County	Year 1990				Year 2000				Year 2010			
	SEDIP [2] Projections		OESC [3] Projections		SEDIP Projections		OESC Projections		SEDIP Projections		OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Population Served	Average Daily Use (Mgal/d)
Coal	0.511	5,655	5,308	0.480	0.599	6,325	5,514	0.521	0.685	6,937	5,505	0.544
Hughes	1.522	11,830	10,835	1.386	1.734	12,980	10,340	1.377	1.978	13,960	9,845	1.359
Lincoln	2.072	16,766	16,176	1.997	2.531	19,870	18,230	2.322	3.017	22,810	20,380	2.683
Okfuskee	1.066	11,420	10,830	1.011	1.198	11,990	10,150	1.015	1.360	12,920	9,850	1.037
Pawnee	1.913	20,832	19,651	1.804	2.219	23,568	20,994	1.978	2.527	25,977	22,260	2.162
Payne	9.127	61,830	59,620	8.766	10.786	70,860	63,760	9.704	12.418	79,310	68,050	10.655
Pontotoc	5.996	31,730	29,950	5.659	6.840	35,240	30,760	5.970	7.648	38,400	31,190	6.212
Pottawatomie	5.718	47,355	44,387	5.381	6.815	52,916	46,352	6.040	7.869	58,942	49,024	6.631
Seminole	2.395	19,570	20,520	2.510	2.758	21,520	20,410	2.615	3.117	23,350	19,930	2.667

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[1] Source: Corps of Engineers, data sheets, December 1984.

[2] SEDIP = Successful Economic Development Initiative Plans.

[3] OESC = Oklahoma Employment Security Commission.

Table IX-18 (Continued)

Summary of Comparative Water Demand Projections for Study Area [1]

(East-Central Oklahoma Water Supply Study, January 1985)

County	Year 2020				Year 2030				Year 2040			
	SEDIP [2] Projections		OESC [3] Projections		SEDIP Projections		OESC Projections		SEDIP Projections		OESC Projections	
	Average Daily Use (Mgal/d)	Population Served	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Population Served	Average Daily Use (Mgal/d)	Average Daily Use (Mgal/d)	Population Served	Population Served	Average Daily Use (Mgal/d)
Coal	0.789	7,635	5,546	0.573	0.886	8,268	5,376	0.576	1.000	9,005	5,217	0.580
Hughes	2.168	15,030	8,970	1.287	2.367	15,870	8,005	1.179	2.540	16,550	7,030	1.062
Lincoln	3.466	25,570	22,290	3.015	3.952	28,310	23,860	3.325	4.449	30,940	25,390	3.653
Okfuskee	1.549	14,010	9,410	1.039	1.773	15,340	8,970	1.037	2.029	16,890	8,630	1.037
Pawnee	2.803	27,889	23,129	2.319	3.070	29,536	23,716	2.456	3.342	31,055	24,194	2.588
Payne	14.041	87,250	70,970	11.033	15.705	94,600	72,390	12.016	17.298	101,590	73,790	12.564
Pontotoc	8.443	41,370	31,010	6.328	9.244	44,260	30,160	6.299	10.021	46,920	29,380	6.276
Pottawatomie	8.951	64,668	50,978	7.188	10.133	70,592	52,114	7.663	11.326	76,058	53,256	8.190
Seminole	3.507	25,190	19,070	2.556	3.993	27,560	18,090	2.623	4.546	30,070	17,160	2.588

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[1] Source: Corps of Engineers, data sheets, December 1984.

[2] SEDIP = Successful Economic Development Initiative Plans.

[3] OESC = Oklahoma Employment Security Commission.

Table IX-19

Comparison of Available Water Supplies With Mid- and Long-Range Water Demand Projections 1/

(East-Central Oklahoma Water Supply Study, January 1985, Revised March 1985)

Water User Entity	Year 2010			Year 2040		
	SEDIP 2/ Projection Demand (Mgal/d)	Available Water Supply [Prior to 1990] (Mgal/d)	OESC 3/ Projection Demand (Mgal/d)	SEDIP Projection Demand (Mgal/d)	Available Water Supply [Prior to 1990] (Mgal/d)	OESC Projection Demand (Mgal/d)
COAL						
Coalgate PWA (supplies RWD Nos. 1, 2, and 5; Clarita-Olney Water Company, Inc.; and Round Hill Water Company, Inc., No. 4)	0.560	S 1.785	0.444	0.786	S 1.785	0.455
Lehigh PWA	0.043	GW 0.045	0.034	0.031	GW 0.045	0.019
Tupelo PWA	0.082	GW 0.050	0.066	0.183	GW 0.050	0.106
HUGHES						
Calvin	0.082	GW 0.070	0.057	0.059	GW 0.070	0.024
Dustin	0.027	S 0.134	0.019	0.049	S 0.134	0.020
Holdenville (supplies RWD Nos. 3 and 4 plus Lamar and Atwood)	1.346	S 2.053	0.911	1.822	S 2.053	0.708
Wetumka (supplies RWD No. 1)	0.462	S 0.714	0.323	0.526	S 0.714	0.262
RWD No. 2 (includes Ashland, Haywood, Hickory Hills, Stuart, and a small area in Pittsburg County)	0.041	GW 0.110	0.035	0.047	GW 0.110	0.033
LINCOLN						
Carney	0.173	GW 0.090	0.154	0.346	GW 0.090	0.283
Chandler (supplies Davenport and RWD No. 2)	0.675	S 4.541	0.602	0.819	S 4.541	0.819
Meeker	0.257	S 0.179	0.230	0.430	S 0.179	0.353
Prague	1.020	TTL 1.117 (S 0.491) (GW 0.626)	0.900	1.470	TTL 1.117 (S 0.491) (GW 0.626)	1.210
Stroud	0.563	S 1.161	0.505	0.818	S 1.161	0.671
Tryon	0.063	GW 0.026	0.055	0.116	GW 0.026	0.096
Wellston	0.123	GW 0.075	0.109	0.151	GW 0.075	0.124
RWD No. 1 (includes 24 percent of Sparks)	0.053	S 0.024	0.047	0.077	S 0.024	0.062
OKFUSKEE						
Okemah (supplies RWD Nos. 2 and 3 and Seminole County RW&SWMD No. 3 and includes Castle, Cromwell, Clearview, and Pharoah)	1.044	S 2.946	0.800	1.635	S 2.946	0.836
Paden	0.052	GW 0.050	0.039	0.082	GW 0.050	0.042
Weleetka	0.243	S 0.179	0.183	0.282	S 0.179	0.143
RWD No. 1 (serves Boley)	0.021	GW 0.120	0.015	0.030	GW 0.120	0.016
PAWNEE 4/						
Cleveland (supplies RWD No. 2, which includes Terlton)	0.531	S 0.670	0.454	0.691	S 0.670	0.560
Hallett	0.051	GW 0.192	0.454	0.072	GW 0.192	0.058
Jennings	0.027	GW 0.070	0.023	0.030	GW 0.070	0.024
Pawnee (buys supplemental supply from Tri-County Development Authority) 5/	0.174	S 0.848	0.148	0.092	S 0.848	0.073
Ralston (supplies Ralston RWC)	0.052	GW 0.290	0.044	0.065	GW 0.290	0.053
Westport	0.045	GW 0.015	0.039	0.090	GW 0.015	0.073
RWD No. 1	0.240	GW 0.093	0.205	0.425	0.093	0.344
Tri-County Development Authority 5/ (supplies 9 member entities: Glencoe; Pawnee [supplemental supply only]; Yale; Big Creek RWC; Blackburn-Skedee RWC; 51 East Water, Inc.; Morr Water Company, Inc.; Pawnee County RWD No. 3; and Yale RWC, which in turn supply municipalities of Blackburn, Skedee, Maramec, and Quay)	1.407	S 2.238	1.206	1.877	S 2.238	1.403

1/ Available water supply data derived from tables IX-2 and IX-4. Water demand projections derived from tables IX-9 through IX-17.

2/ SEDIP = Successful Economic Development Initiative Plan.

3/ OESC = Oklahoma Employment Security Commission.

4/ RWD No. 2, Inc., purchases water supply from city of Mannford in Creek County. Capability of Mannford to supply long-range water needs of RWD No. 2 and other eastern Pawnee County entities needs to be evaluated.

5/ Assumption for water demand projections was that Pawnee would self-supply 51 percent and purchase 49-percent supplemental supply from Tri-County Development Authority. This table makes it obvious that the supplemental supply percentage needs to be revised to a much lower realistic figure.

Note: S = surface water, GW = ground water, and TTL = total.

Table IX-19 (Continued)
Comparison of Available Water Supplies
With Mid- and Long-Range Water Demand Projections 1/
(East-Central Oklahoma Water Supply Study, January 1985, Revised March 1985)

Water User Entity	Year 2010			Year 2040		
	SEDIP 2/ Projection Demand (Mgal/d)	Available Water Supply [Prior to 1990] (Mgal/d)	OESC 3/ Projection Demand (Mgal/d)	SEDIP Projection Demand (Mgal/d)	Available Water Supply [Prior to 1990] (Mgal/d)	OESC Projection Demand (Mgal/d)
PAYNE						
Cushing	1.512	TTL 1.967 (S 1.607) (GW 0.360)	1.298	1.807	TTL 1.967 (S 1.607) (GW 0.360)	1.311
Perkins	0.399	GW 0.360	0.342	0.877	GW 0.360	0.637
Ripley	0.079	GW 0.050	0.068	0.151	GW 0.050	0.110
Stillwater (supplies RWD No. 1 and RWC No. 3)	10.330	S≈22.000 6/	8.864	14.350	S≈22.000 6/	10.424
RWD No. 3	0.098	GW 0.120	0.083	0.113	GW 0.120	0.082
PONTOTOC						
Ada PWA (supplies RWD Nos. 1 through 8 as well as Anloso, Byng, Fittstown, Harden City, Jesse, and Latta)	7.041	GW 8.160	5.720	9.108	8.160	5.705
Allen PWA	0.201	GW 0.170	0.163	0.270	GW 0.170	0.169
Francis	0.111	GW 0.115	0.089	0.203	GW 0.115	0.127
Roff	0.178	GW 0.118	0.145	0.268	GW 0.118	0.168
Stonewall PWA	0.117	GW 0.070	0.095	0.172	GW 0.095	0.107
POTTAWATOMIE						
Asher	0.064	GW 0.025	0.053	0.136	GW 0.025	0.096
McLoud	0.244	GW 0.306	0.203	0.448	GW 0.306	0.314
Maud	0.264	GW 0.180	0.219	0.353	GW 0.180	0.247
Shawnee (supplies Bethel Acres RWD No. 1)	5.547	S 3.303 7/	4.702	7.718	S 3.303 7/	5.665
Tecumseh	1.004	TTL 0.482 (S 0.312) (GW 0.170)	0.835	1.517	TTL 0.482 (S 0.312) (GW 0.170)	1.063
Wanette	0.054	GW 0.050	0.045	0.078	GW 0.050	0.054
Earlsboro Water Co. (supplies Earlsboro)	0.368	GW 0.300	0.306	0.420	GW 0.300	0.293
St. Louis UA (supplies St. Louis and Pearson)	0.030	GW 0.020	0.025	0.040	GW 0.020	0.028
SEMINOLE						
Bowlegs	0.025	GW 0.030	0.021	0.049	GW 0.030	0.028
Konawa	0.243	GW 0.200	0.207	0.301	GW 0.200	0.171
Sasakwa	0.030	GW 0.018	0.025	0.056	GW 0.018	0.032
Seminole	1.700	GW 2.380	1.460	2.620	GW 2.380	1.490
Wewoka (supplies RWD Nos. 1, 2, and 5)	0.934	S 0.893	0.797	1.390	S 0.893	0.792
Bowlegs-Lima Water District (supplies Lima and part of Bowlegs)	0.161	GW 0.200	0.137	0.115	GW 0.200	0.065
Sasakwa RWD of the Seminole Nation	0.024	GW 0.028	0.020	0.015	GW 0.028	0.010

1/ Available Water Supply data derived from tables IX-2 and IX-4. Water demand projections derived from tables IX-9 through IX-17.

2/ SEDIP = Successful Economic Development Initiative Plan.

3/ OESC = Oklahoma Employment Security Commission.

4/ RWD No. 2, Inc., purchases water supply from city of Mannford in Creek County. Capability of Mannford to supply long-range water needs of RWD No. 2 and other eastern Pawnee County entities needs to be evaluated.

5/ Assumption for water demand projections was that Pawnee would self-supply 51 percent and purchase 49-percent supplemental supply from Tri-County Development Authority. This table makes it obvious that the supplemental supply percentage needs to be revised to a much lower realistic figure.

6/ Components of total available supply are 13 Mgal/d from Kaw Reservoir, 6.249 Mgal/d from Lake Carl Blackwell, and 2.678 Mgal/d from Lake McMurtry. City of Stillwell needs are approximately 75 percent of the total demand, which they will meet with supplies from Kaw Reservoir. Lake McMurtry will be held in reserve for future growth and peak demands. The OSU needs are approximately 25 percent of total demand and will be met with supplies from Lake Carl Blackwell.

7/ City of Shawnee has built a pipeline turnout from the Oklahoma City aqueduct (which conveys water from Atoka Reservoir to Stanley Draper Lake) to Shawnee Reservoir (No. 1). No specific amount of supply can be listed because plan is for Shawnee to purchase emergency supplemental supplies when needed, if supply is available from Oklahoma City.

Note: S = surface water, GW = ground water, and TTL = total.

occurring in year 2040 with the exception of four entities having maximum projected water demands occurring at the year 2010 mid-range point due to their particular pattern of projected population decline. They are Calvin (Hughes County), Pawnee (Pawnee County), Sasakwa (Seminole County), and Sasakwa RWD of the Seminole Nation (Seminole County). It should be noted that demand projections are unrealistically low for Pawnee. This is the result of an erroneous assumption in table IX-9 that Pawnee would purchase 49 percent of its water from Tri-County Development Authority. This percentage should be much lower since Pawnee's projected population decline will not require a large supply of supplemental water.

4. Preliminary estimate of need for additional M&I water supplies. Table IX-20 displays the summary of preliminary findings of need for additional M&I water supplies for the study area from the present through the year 2040. Part A of the table displays the 14 water user entities having water supplies that appear to be adequate to meet projected future needs to the year 2040.

Part B lists the 10 entities having need for high-priority investigations to resolve problems with incomplete or conflicting data and to establish urgency of need. A brief listing of each entity's problems is provided.

Part C lists the additional M&I water supplies required to meet current mid-range (year 2010) and long-range (year 2040) projected needs for each entity. It also ranks priority of need for each entity.

5. Summary. In summary of preliminary findings, 54 entities in the study area are sources of M&I water supply. Of these, 16 rely on surface water supplies (excluding use of standby wells), 3 use mixed supplies having significant percentages of both surface and ground water, and 35 rely on ground water. In terms of adequacy of water supplies for current through long-range needs, 14 of the 54 entities appear to have adequate supplies through the year 2040 projected needs, 10 need further investigation to determine need and associated priority, and 30 have been determined to need additional supplies. Of the 30 entities with determined needs, 23 have current or near-term (circa year 1990) needs priority, 6 have mid-term (circa year 2010) priority, and 1 has long-term (circa year 2040) priority.

E. Irrigation Demands

Data on reported irrigation by crops and acres were displayed earlier in table VII-5 (chapter VII). The most recent data on irrigation acreage and water use is for 1981. These data are summarized in table IX-21.

As can be seen, the data from the two sources do not match. The following narrative from OWRB describes some of the reasons for the disparity--but not all.

Table IX-20
Summary of Preliminary Findings of Study Area Need for Additional M&I Water Supplies From the Present Through the Year 2040
(East-Central Oklahoma Water Supply Study, January 1985)

Part A - Entities Having Water Supplies That Appear to be Adequate to Meet Projected Future Needs to the Year 2040

COAL
- Coalgate

HUGHES
- Dustin
- RWD No. 2 (Stuart)

LINCOLN
- Chandler

OKFUSKEE
- Okemah
- RWD No. 1 (Boley)

PAWNEE
- Hallett
- Jennings
- Pawnee
- Ralston
- Tri-County Development Authority 1/

PAYNE
- Stillwater
- RWD No. 3

SEMINOLE
- Bowlegs-Lima Water District

Part B - High Priority Investigations Needed to Resolve Problems with Incomplete or Conflicting Data and Establish Urgency of Needs

Ada (Pontotoc County)	City's usage includes considerable commercial, industrial, and rural usage that cannot be accurately projected using population and gallons-per-capita-per-day factors. This is especially true for the influence this type of usage has on peak demands. Projections for peak demands are needed in order to determine the total additional well capacity needed to assure adequate supplies. This same information would be needed to determine the total replacement supplies needed if the city decides to request that Reclamation also study providing the city with a new water supply.
Carney (Lincoln County)	Capacity of three wells is reported to be 0.090 Mgal/d. Peak demands are 0.130 Mgal/d. No shortages are reported. Wells are reported to be in Garber-Wellington Formation. The OWRB and TVA maps indicate this could not be true. The TVA map would place wells in low-yielding minor Pennsylvanian sandstone. Dependable well capability information is needed.
Cleveland (Pawnee County)	The city is said to be negotiating with Tri-County Development Authority for a supplemental water supply. If these negotiations have not reached a substantive agreement by mid-1985, Reclamation will need to address supply needs. Drought of 1980-1981 resulted in exceedingly low (2 feet) reservoir levels. Determination needs to be made on why reservoir is not yielding to estimated firm expectations. Since RWD No. 2 (Terlton) purchases 70 percent of its water from Cleveland, resolution of its having assured future water supplies rests with resolving Cleveland's problem. It will also be necessary to determine if water sales to RWD No. 1 will be resumed when ample supplies of water are again available.
Cushing (Payne County)	City's peak demands are 308 percent greater than average daily use. Industrial use is said to make up 40 percent of use. Additional study is needed to more accurately determine projected demands, especially peak demands, in order to establish whether additional supplies are needed. Peak demand projections will be needed if the city decides to expand its well field capacity.
Holdenville (Hughes County)	Extremely low reservoir levels reported during drought periods. Estimated firm yield is 2.053 Mgal/d, which is two times the 1.000 Mgal/d peak use. There is a need to determine why the reservoir is not producing expected yield and what the true firm yield is.
Sasakwa and Sasakwa RWD of the Seminole Nation (Seminole County)	Recent media accounts claimed these entities were experiencing loss of ground water supplies due to dry wells or brine-contaminated supplies were unsafe for human consumption and that some people were having to haul in their water. Data needs to be gathered to define the exact nature of the problem and formulate the best, most timely solution.
Stroud (Lincoln County)	Estimated firm yield of reservoir is 1.161 Mgal/d. Peak demands are 0.730 Mgal/d. Treatment plant capacity is 0.750 million gallons. The city has apparently experienced shortages because it has drilled 13 wells for a supplemental supply. All of the wells were abandoned due to very low yields. Entire situation needs to be clarified.
Wetumka (Hughes County)	Same problem as Holdenville above. Estimated firm yield for reservoir is 0.714 Mgal/d, which is 143 percent greater than peak demands.

1/ Assumes sales will not exceed calculated firm yields.

Table IX-20 (Continued)

Summary of Preliminary Findings of Study Area Need for Additional M&I Water Supplies From the Present Through the Year 2040

(East-Central Oklahoma Water Supply Study, January 1985)

Part C - Additional Water Supplies Required by Entities to Meet Current, Mid-Range (Year 2010), and Long-Range (Year 2040) Projected Needs

Water User Entities	Priority of Needs 1/	Minimum Additional Average Daily Supply Needed (Mgal/d)	Maximum Total Projected Average Daily Use (Mgal/d)
COAL			
Lehigh	1	0.010 2/	0.055
Tupelo	2	0.133 2/	0.183
HUGHES			
Calvin	1	0.012 2/	0.082
LINCOLN			
Meeker	1	0.251	0.430
Prague	3	0.353 2/	1.470
Tryon	1	0.090 2/	0.116
Wellston	1	0.076 2/	0.151
RWD No. 1 (Sparks)	1	0.053	0.077
OKFUSKEE			
Paden	3	0.032 2/	0.082
Weleetka	1	0.103	0.282
PAWNEE			
Westport	1	0.075 2/	0.090
RWD No. 1	1	0.332 2/	0.425
PAYNE			
Perkins	3	0.517 2/	0.877
Ripley	2	0.101 2/	0.151
PONTOTOC			
Allen PWA	1	0.100 2/	0.270
Francis	3	0.088 2/	0.203
Roff	1	0.150 2/	0.268
Stonewall PWA	1	0.077 2/	0.172
POTTAWATOMIE			
Asher	1	0.111 2/	0.136
McLoud	4	0.142 2/	0.448
Maud	2	0.173 2/	0.353
Shawnee	1	4.415	7.718
Tecumseh	1	1.035 2/	1.517
Wanette	3	0.028 2/	0.078
Earlsboro Water Co.	2	0.120 2/	0.420
St. Louis UA	2	0.020 2/	0.040
SEMINOLE			
Bowlegs	3	0.019 2/	0.049
Konawa	1	0.101 2/	0.301
Wewoka	1	0.497	1.390
Seminole	2	0.240 2/	2.620

1/ Priority Code:
- 1 = Needed now for reliable supplies to relieve existing or imminent shortages.
- 2 = Needed circa 1990.
- 3 = Needed circa 2010.
- 4 = Needed circa 2040.

2/ Well capability will need to be significantly larger than this figure, in most cases, to meet peak demands. Projections of peak demands will be made in the near future in order to determine this number.

Table IX-21
1981 Reported Irrigated Acreage and Water Use
(East-Central Oklahoma Water Supply Study, January 1985)

	OWRB Data 1/				OSU Extension Data 2/	
	Ground Water		Surface Water		Ground Water	Surface Water
County	Irrigated (acres)	Water Use (acre-feet)	Irrigated (acres)	Water Use (acre-feet)	Irrigated (acres)	Irrigated (acres)
Coal	0	0	190	157	0	0
Hughes	1,236	867	2,788	2,226	5,145	4,000
Lincoln	37	12	227	135	0	186
Okfuskee	0	0	1,487	898	0	30
Pawnee	0	0	235	123	0	0
Payne	425	176	345	171	240	300
Pontotoc	880	1,474	1,380	1,412	800	1,200
Pottawatomie	879	593	2,375	1,510	280	2,595
Seminole	363	168	208	116	200	1,160
Total	3,820	3,290	9,235	6,748	6,665	9,471

OWRB Total Acreage = 13,055 OSU Total Acreage = 16,136

1/ Source: 1981 Reported Water Use, OWRB 1984.

2/ Source: 1981 Irrigation Survey, Oklahoma, Delbert Schwab, Department of Agricultural Engineering, Oklahoma State University, Stillwater, Oklahoma.

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IRRIGATION

Water used for irrigation is reported as the amount pumped from the source of supply. It includes conveyance loss, if any, in addition to the amount applied to the area of irrigated crops. The amount of water applied to each type of crop was determined by multiplying the acreage times the number of irrigation applications during the growing season, times the depth in inches for each application - all as reported on water use report forms returned to the OWRB during the annual survey. For example, five (5) applications of water to 500 acres of corn with an average of three (3) inches per application, and assuming no conveyance loss, would equal 625 acre-feet per year, equivalent to an average daily application of .56 million gallons.

Climatic conditions, particularly seasonal and annual variations in the amount and distribution of rainfall throughout the state during the growing season, influence the quantity of water withdrawn for irrigation.

Source and Reliability of the Data

The 1981 growing season was milder than 1980 and as a result, 1981 water use for irrigation was expected to be lower. However irrigation acreage reported to the OWRB was considerably less than that compiled by the Extension Service at Oklahoma State University, which was published in their biennial survey. Less than half - 47 percent - of the irrigated acreage reported by OSU was accounted for in the OWRB survey. (Schwab, 1981).

Response to the OWRB survey was particularly poor for grain sorghum, grain corn and alfalfa acreage. Returns were also incomplete for cotton, pasture and peanuts.

Most of the discrepancy between OWRB reports and the OSU publication can be accounted for in a few counties - Texas, Cimarron, Jackson and Caddo - which together account for almost sixty (60) percent of the state's total irrigated acreage. If adjustments are made to the acreage irrigated for these four counties, 1981 water use for irrigation rises to 975,000 acre-feet, or 871 million gallons per day. Future water use studies will provide estimates of irrigation water use based on the data compiled by OSU's irrigation specialists.

These data are shown for illustrative purposes. Irrigation is currently not a major activity in the study area. Given the annual rainfall that normally occurs, irrigation is for a supplemental, not full supply.

Projections of future irrigation water requirements have not been made. This work will be done later as the study progresses to the point of formulating future development alternatives.

F. Other Water Demands

As this study progresses, inventory of existing demands and projected future demands and needs will be completed for other functions in order to complete a comprehensive picture of problems, needs, and opportunities for the study area's water resources.

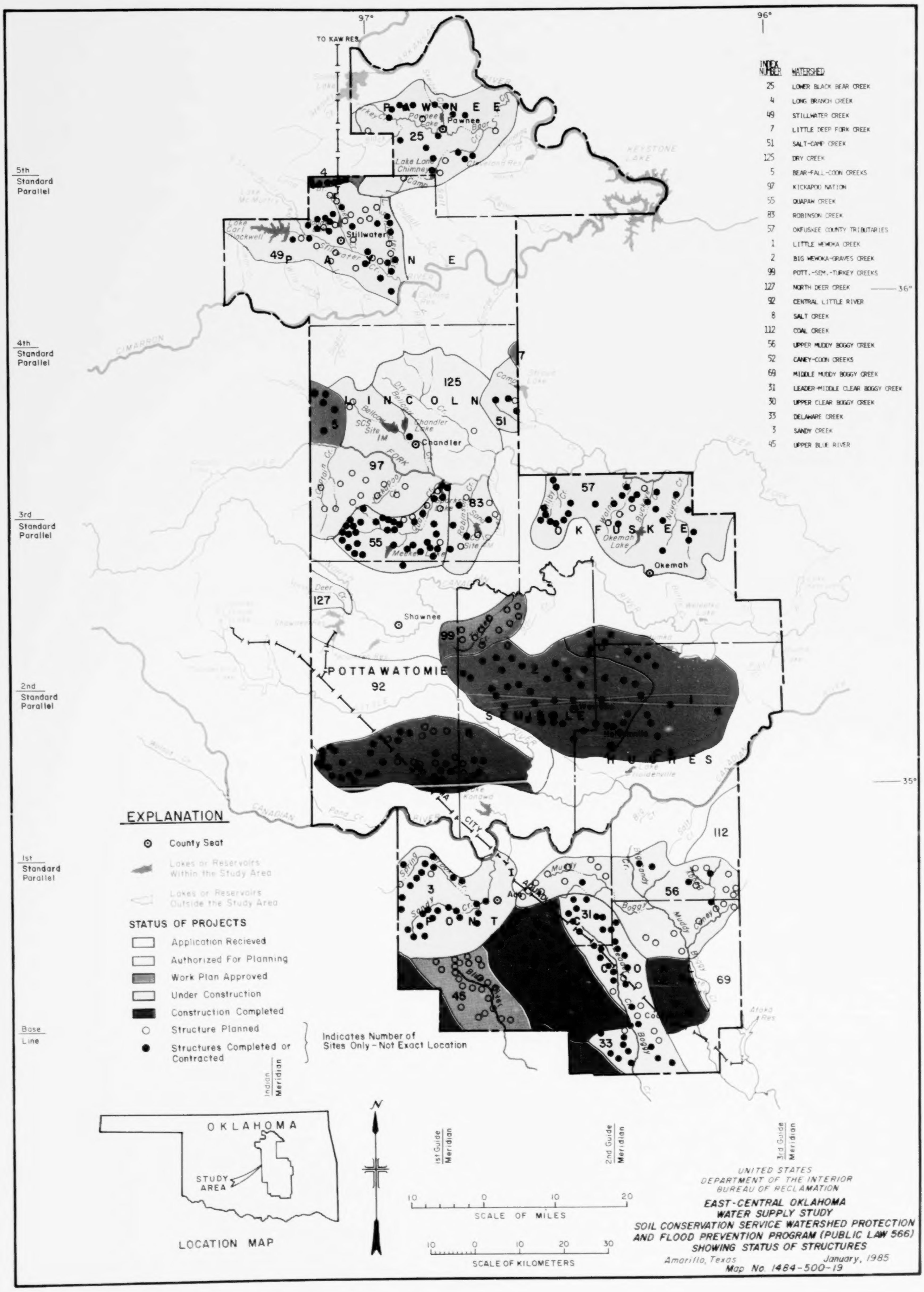
Work remaining to be completed or incorporated includes the functions of hydropower, navigation, recreation, preservation and enhancement of fish and wildlife, water quality augmentation and control, and flood control.

G. Soil Conservation Service Small Watershed Projects

This program is uniquely different from the typical large project missions of the other Federal agencies. Their program is also difficult to summarize. A majority of the existing study area dam structures and associated reservoirs was developed under this program as are a majority of the planned potential structures. It is conceivable that this program could have greater impact on the future of the study area than it presently has. For that reason, this discussion has been placed just before the topic of potential future water supplies.

The Watershed Protection and Flood Prevention Act (Public Law 83-566) was enacted in 1954. The program bridges the resource-development gap between soil and water conservation work of individual landowners and large Federal and State public works projects for water resource development in major river valleys. Typical objectives of these projects are the reduction of sediment and floodwater damages to agricultural flood plains, irrigation development, provision of M&I water supplies, development of recreational resources, and improvement of fish and wildlife resources. Constraints of the program are that a watershed project cannot exceed a total drainage area of 250,000 acres and that individual structures may not exceed 12,500 acre-feet of flood control storage or a total of 25,000 acre-feet of multipurpose storage.

Some examples of existing project multipurpose developments would include Coalgate Reservoir; Lake McMurtry; and Meeker, Sparks, Sportsman, and Stroud Lakes. Multipurpose structures under construction or recently completed include Boomer Lake rehabilitation, Kickapoo Nations Watershed Site 1M, Lake Lone Chimney, and Robinson Creek Watershed Site 4M. North Deer Creek Watershed Site 1M has been proposed for development. Map No. 1484-500-19 shows all of the watershed projects in the study area (entirely or partially) and their status. Table IX-22 details the status of planned and completed features for each of the watershed projects.


97°
96°
TO KAW RES.
PAWNEE
25
Pawnee
Lake Lone Chimney
4
5th Standard Parallel
4th Standard Parallel
3rd Standard Parallel
2nd Standard Parallel
1st Standard Parallel
Base Line
Stillwater
49
PAYNE
KEYSTONE LAKE
CIMARRON
LINCOLN
125
7
51
5
SCS Site 1M
Chandler Lake
Chandler
97
83
55
57
OKFUSKEE
Okemah Lake
Okemah
127
Shawnee
99
POTTAWATOMIE
92
SEMINOLE
Wewoka
HUGHES
Holdenville
Lake Konawa
CANADIAN
112
3
PONTOTOC
Ada
31
30
56
69
45
33
Coalgate
36°
35°
EXPLANATION
County Seat
Lakes or Reservoirs Within the Study Area
Lakes or Reservoirs Outside the Study Area
STATUS OF PROJECTS
Application Recieved
Authorized For Planning
Work Plan Approved
Under Construction
Construction Completed
Structure Planned
Structures Completed or Contracted
Indicates Number of Sites Only - Not Exact Location
Indian Meridian
1st Guide Meridian
2nd Guide Meridian
3rd Guide Meridian
OKLAHOMA
STUDY AREA
LOCATION MAP
N
10 0 10 20
SCALE OF MILES
10 0 10 20 30
SCALE OF KILOMETERS

INDEX NUMBER	WATERSHED
25	LOWER BLACK BEAR CREEK
4	LONG BRANCH CREEK
49	STILLWATER CREEK
7	LITTLE DEEP FORK CREEK
51	SALT-CAMP CREEK
125	DRY CREEK
5	BEAR-FALL-COON CREEKS
97	KICKAPOO NATION
55	QUAPAW CREEK
83	ROBINSON CREEK
57	OKFUSKEE COUNTY TRIBUTARIES
1	LITTLE WEWOKA CREEK
2	BIG WEWOKA-GRAVES CREEK
99	POTT.-SEM.-TURKEY CREEKS
127	NORTH DEER CREEK
92	CENTRAL LITTLE RIVER
8	SALT CREEK
112	COAL CREEK
56	UPPER MUDDY BOGGY CREEK
52	CANEY-COON CREEKS
69	MIDDLE MUDDY BOGGY CREEK
31	LEADER-MIDDLE CLEAR BOGGY CREEK
30	UPPER CLEAR BOGGY CREEK
33	DELAWARE CREEK
3	SANDY CREEK
45	UPPER BLUE RIVER

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EAST-CENTRAL OKLAHOMA
WATER SUPPLY STUDY
SOIL CONSERVATION SERVICE WATERSHED PROTECTION
AND FLOOD PREVENTION PROGRAM (PUBLIC LAW 566)
SHOWING STATUS OF STRUCTURES

Amarillo, Texas January, 1985
Map No. 1484-500-19

Table IX-22
1984 Status of SCS Watershed Projects (Public Law 83-566) in Study Area 1/
(East-Central Oklahoma Water Supply Study, January 1985)

Index No. on Map No. 1484-500-19	Watershed Projects
25	Lower Black Bear Creek Watershed Planned: 25 floodwater-retarding structures 1 multipurpose structure with municipal water Completed: 17 floodwater sites completed 1 multipurpose structure under construction (Lake Lone Chimney - Site 19M)
4	Long Branch Creek Watershed Project completed in 1977: 11 floodwater-retarding structures
49	Stillwater Creek Watershed Planned: 47 floodwater-retarding structures 5 multipurpose structures with irrigation water supply 2 multipurpose structures with municipal water supply, one of which also includes recreation 6.3 miles of channel improvement Completed: 2 multipurpose structures 26 floodwater-retarding structures
7	Little Deep Fork Creek Watershed Project completed in 1973: 56 floodwater-retarding structures 5.8 miles of channel improvement
51	Salt-Camp Creeks Planned: 1 multipurpose structure for recreation and municipal water 24 floodwater-retarding structures Completed: 1 multipurpose structure 4 floodwater-retarding structures
125	Dry Creek Authorized for planning: September 2, 1977 Status: Final plan - Environmental Statement by July 1985
5	Bear-Fall-Coon Creeks Project completed in 1967: 1 multipurpose structure with irrigation 30 floodwater-retarding structures
97	Kickapoo Nations Planned: 19 floodwater-retarding structures 1 multipurpose structure for flood control, municipal water, and recreation Completed: 1 floodwater-retarding structure Ground-breaking ceremony and some right-of-way acquisition for multipurpose structure
55	Quapaw Creek Planned: 2 multipurpose structures for municipal water with one also having recreation 41 floodwater-retarding structures 8.8 miles channel improvements Completed: 2 multipurpose structures 36 floodwater-retarding structures
83	Robinson Creek Planned: 1 multipurpose structure for flood control, municipal water, and recreation 10 floodwater-retarding structures Completed: 2 floodwater-retarding structures Under construction - 2 floodwater-retarding and 1 multipurpose structure

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1/ Source: 1984 Oklahoma Watershed Summary, SCS, Stillwater, Oklahoma.

Table IX-22 (Continued)
1984 Status of SCS Watershed Projects (Public Law 83-566) in Study Area [1/]
(East-Central Oklahoma Water Supply Study, January 1985)

Index No. on Map No. 1484-500-19	Watershed Projects
57	Okfuskee County Tributaries Planned: 1 multipurpose structure for municipal water and recreation 1 multipurpose structure for irrigation water 33 floodwater-retarding structures 14 miles channel improvement Completed: 27 floodwater-retarding structures 2 multipurpose structures
1	Little Wewoka-Graves Creek Project completed in 1972: 16 floodwater-retarding structures
2	Big Wewoka Creek Project Completed in 1967: 1 multipurpose structure including wildlife 41 floodwater-retarding structures
99	Pott-Sem-Turkey Creek Planned: 11 floodwater-retarding structures Completed: None
127	North Deer Creek Authorized for Planning: August 1982 Status: Plan and Environmental Statement submitted for technical review - December 1984
92	Central Little River Application for planning received and approved by the Oklahoma Conservation Commission
8	Salt Creek Project essentially completed: 35 floodwater-retarding structures installed (14 originally proposed structures deleted from plan)
112	Coal Creek Application for planning received and approved by the Oklahoma Conservation Commission
56	Upper Muddy Boggy Creek Planned: 36 floodwater-retarding structures Completed: 15 floodwater-retarding structures 2 floodwater retarding structures under construction
52	Caney-Coon Creek Project completed in 1975: 2 floodwater-retarding structures 1 multipurpose structure with municipal water
69	Middle Muddy Boggy Creek Application for planning received and approved by the Oklahoma Conservation Commission
31	Leader-Middle Clear Boggy Creek Planned: 43 floodwater-retarding structures Completed: 33 floodwater-retarding structures
30	Upper Clear Boggy Creek Project completed in 1983: 49 floodwater-retarding structures
33	Delaware Creek Project completed in 1979: 13 floodwater-retarding structures

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[1/] Source: 1984 Oklahoma Watershed Summary, SCS, Stillwater, Oklahoma.

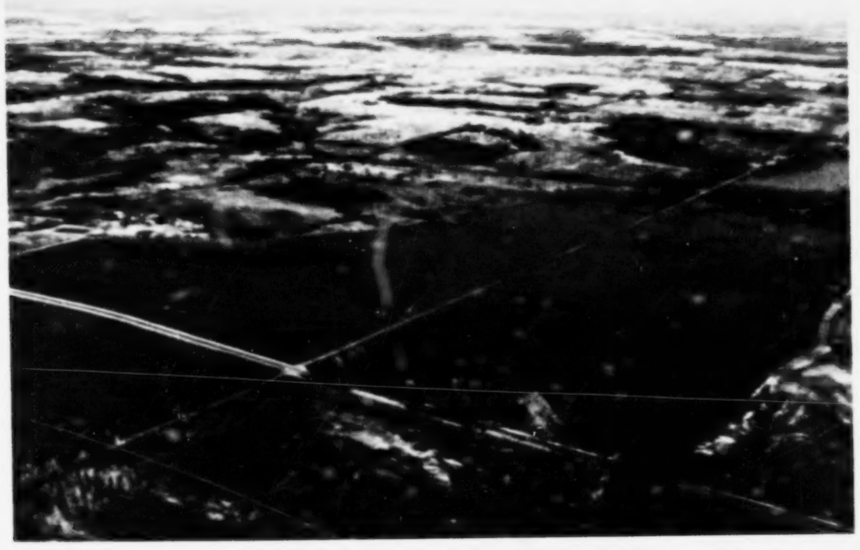
Table IX-22 (Continued)

1984 Status of SCS Watershed Projects (Public Law 83-566) in Study Area [1/]

(East-Central Oklahoma Water Supply Study, January 1985)

Index No. on Map No. 1484-500-19	Watershed Projects
3	Sandy Creek
	Planned: 33 floodwater-retarding structures
	Completed: 29 floodwater-retarding structures
45	Upper Blue River
	Planned: 74 floodwater-retarding structures
	Completed: None

1/ Source: 1984 Oklahoma Watershed Summary, SCS, Stillwater, Oklahoma.



Deep Fork is shown in flood stage. Flood control is one of the many purposes for water resource planning and development.

Meeker Lake is an example of a SCS multiple-purpose structure, providing flood control, municipal water, recreation, and fish and wildlife benefits.

As mentioned earlier under the M&I water discussion, the Administration has proposed drastic successive budget cuts for the next 3 fiscal years; the end result of which would be the reduction of the SCS mission to nothing more than provision of technical assistance. Since there is no way of predicting to what degree this proposal will be legislatively enacted during the next several years, Reclamation's planning study will need to develop contingency plans for meeting study area needs without contributions from the SCS program.

H. Potential Water Supplies to Meet Current and Projected Needs

1. Ground water. Determination needs to be made of how much additional water could be pumped from each of the study area aquifers. An attempt will be made to define those areas where wells are most likely to produce water of suitable quality that does not exceed State primary and secondary drinking water standards. This same work will also allow identification of supplies suitable for irrigation. Reclamation plans to initiate this work soon in coordination with USGS, the Oklahoma Geological Survey, OWRB, and the State Department of Public Health.

2. Surface water

a. Additional supplies available from existing reservoirs--Analysis of table IX-19 reveals the following potential available surpluses based on preliminary findings:

(1) Coalgate Reservoir--Maximum projected demands of 0.786 Mgal/d and estimated firm yield of 1.785 Mgal/d appear to show there might be an available surplus of about 1.000 Mgal/d.

(2) Kickapoo Nations Watershed Site 1M (Chandler)--Maximum projected demands of 0.819 Mgal/d for Chandler and a combined (also includes Chandler Lake) total estimated firm yield of 4.541 Mgal/d appear to indicate that there might be a potential available surplus of as much as 3.722 Mgal/d.

(3) Okemah Lake--Projected maximum demands of 1.635 Mgal/d for Okemah and an estimated firm yield of 2.946 Mgal/d for the lake indicate potential availability of up to about 1.311 Mgal/d.

(4) Lakes Carl Blackwell and McMurtry (Stillwater)--The maximum projected demand for Stillwater is 14.350 Mgal/d. If the present plan of operations is continued into the future, Stillwater's 75 percent would be 10.763 Mgal/d, leaving about 2.237 Mgal/d capacity in their Kaw Reservoir pipeline for meeting peak demands. The OSU's 25-percent share from Lake Carl Blackwell would amount to 3.588 Mgal/d. Stillwater plans to hold Lake McMurtry's calculated firm yield of 2.678 Mgal/d in reserve for possible future use in meeting peak demands. Lake Carl Blackwell's calculated firm yield of 6.249 Mgal/d minus OSU's 3.588 Mgal/d share of maximum projected future demands would leave a surplus of 2.661 Mgal/d. Lake McMurtry's supply of 2.678 Mgal/d plus Lake Carl Blackwell's surplus of 2.661 Mgal/d would provide a combined surplus of 5.339 Mgal/d in the two reservoirs, less whatever is needed to supplement the 2.237 Mgal/d excess pipeline capacity in meeting as yet undetermined projected year 2040 peak demands.

b. Possible potential irrigation water supplies in SCS floodwater-retarding structures--These structures do not store floodwaters. They temporarily contain them as they are released at a controlled rate that reduces streamflow so as to lessen downstream flood damage and destruction. Flood storage capacity must be evacuated in order to be ready to contain the next flood event. These structures would lose their flood-retarding capability if the space needed to contain floodflows were allowed to fill with sediments. Therefore, SCS plans a permanent storage space behind these structures to store 100 years' accumulation of sediments (50 years on older structures). Any of this space not yet filled with sediments stores water. Inventory of the amount of this water that would be available each decade into the future needs to be accomplished in order to determine how much water might be available for adjacent landowners to use for irrigating pasture; traditional cash crops; and especially for irrigating small acreages of specialty crops such as fruit, vegetables, and berries.

c. Potential water supply reservoirs--A search of previous investigations and surveys found 30 previously identified reservoir sites that appear to have potential as multipurpose reservoirs (see map No. 1484-500-8). Since work on the current study was just recently begun, acquisition of data and completion of analyses has not progressed to the point that viability of any of these sites can be determined. Table IX-23 displays estimated firm yields and preliminary cost estimates for these potential damsites. Preliminary cost estimates for these potential reservoirs are at subappraisal level and were obtained from cost curves and previous studies. The construction costs include 25 percent for contingencies and 25 percent for overhead and administrative costs. These costs do not include flood control storage. Since the plan formulation process is just beginning, layout of distribution systems would be premature. Additional sites may be identified as the study progesses.

This view shows the reservoir area for the potential Tate Mountain damsite in Seminole County.

The dam axis of the potential Hickory Ridge site crosses the North Canadian River in the right center foreground. The upstream area shown would be part of the reservoir.

I. Hydropower Potential for the Study Area

Successful realization of comprehensive economic development over a long-range time frame will add to the study area's projected electrical energy needs. If the study area's petroleum and gas production decline sharply during the next 10 to 20 years as forecast (see chapter VI), the area will also need additional electrical energy to replace these once plentiful and inexpensive supplies. As the study progresses, existing and projected electric power demands will be determined. On a regional basis, projected need for additional generating capacity for the Southwest Power Pool (SPP) is shown in Table IX-24. This need was iterated by the Southwestern Power Administration (SWPA), which is the agency authorized to market federally generated hydroelectric power and energy in Arkansas, Kansas, Louisiana, Missouri, Oklahoma, and part of Texas. In a February 19, 1985, letter to Reclamation, SWPA said: "The demand for Federally generated hydroelectric power in our marketing area far exceeds our existing capability and therefore, we are vitally interested in the development of new Federal facilities."

Since the study area has a great deal of flowing water, which is a renewable resource, there is a growing interest in hydropower in the region.

Thirteen potential hydropower sites in the study area have been identified and preliminary studies performed in previous investigations. Reclamation's "Western States Inventory of Low-Head Hydroelectric Sites (Phase II), October 1980" identified 10 sites. The Corps, as part of its comprehensive reconnaissance studies of the Arkansas and Red River Basins, reported seven potential hydropower sites in the study area during an interagency planning meeting held in June 1984. Four sites are included in both studies. Table IX-25 presents the results of these studies. Additional damsites identified for this study will also be evaluated for hydropower potential. Map No. 1484-500-8 shows the location of previously identified hydropower sites and some of the additional damsites which will be studies.

J. Problems and Needs

1. Data acquisition. Federal, State, and Sub-State agencies all report difficulty in obtaining accurate needed data from smaller municipalities and rural water systems. A specific function within a State agency needs to be given specific clearinghouse responsibility for acquisition, analysis, and dissemination of all information concerning entities providing public drinking water

Table IX-23
Estimated Firm Yields and Preliminary Cost Estimates For Previously Identified Potential Damsites
(East-Central Oklahoma Water Supply Study, January 1985)

Name of Damsite map No. 1484-500-8	Location		Hydrology 1/			Estimated Costs 2/
	Stream	County	Contributing Drainage Area (mi^2)	Conservation Storage (acre-feet)	Estimated Firm Yield (acre-ft/yr)	(dollars)
Lela	Black Bear Creek	Pawnee	545	199,200	48,400	68,724,000
Fallis	Bear Creek	Lincoln	94	33,000	9,900	18,150,000
Wellston	Captain Creek	Lincoln	58	25,000	7,700	13,750,000
Kendrick	Dry Creek	Lincoln	82	28,000	7,800	15,400,000
Davenport	Dry Creek	Lincoln	176	67,000	18,500	33,500,000
Quapaw	Quapaw Creek	Lincoln	69	33,000	9,200	18,150,000
Paden	Hilliby Creek	Okfuskee	39	19,000	5,200	11,400,000
Welty	Deep Fork	Okfuskee	1,387	600,000	166,000	112,200,000
Tuskegee	Deep Fork	Okfuskee	1,500	650,000	180,000	110,500,000
Morse	Nuyaka Creek	Okfuskee	84	58,000	16,000	29,000,000
Nuyaka	Deep Fork	Okfuskee	2,146	-- 3/	-- 3/	-- 3/
Boley	North Canadian River	Okfuskee	1,575	680,000	189,000	110,840,000
Hickory Ridge	North Canadian River	Okfuskee	1,789	775,000	215,000	110,050,000
Centerpoint	Unnamed	Pottawatomie	7.4	3,000	700	1,800,000
North Deer Creek	North Deer Creek	Pottawatomie	38.5	10,082	2,020	6,049,000
Pecan Creek	Pecan Creek	Pottawatomie	32	15,000	3,360	9,000,000
Little River (near Tecumseh)	Little River	Pottawatomie	200	175,000	16,800	63,350,000
Oxbow	Wewoka Creek	Hughes	343	265,000	74,000	80,825,000
Atwood	Canadian River	Hughes	22,110 4/	500,000	400,000	106,000,000
Tate Mountain	Little River	Seminole	342	180,000	44,500	64,080,000
Sasakwa	Little River	Seminole	613	325,000	80,000	89,375,000
Asher	Canadian River	Pontotoc	21,660 4/	500,000	400,000	106,000,000
Byng	Canadian River	Pontotoc	21,960 4/	500,000	400,000	106,000,000
Steedman	Muddy Boggy Creek	Pontotoc	27	24,000	6,600	13,200,000
Spring Creek	Spring Creek	Pontotoc	46	31,000	8,700	17,050,000
Vanoss	Sandy Creek	Pontotoc	63	43,000	12,000	21,500,000
Ada	Sandy Creek	Pontotoc	195	135,000	37,000	52,650,000
Parker 5/	Muddy Boggy Creek	Coal	172	114,650	47,000	47,694,000
Non	Caney Creek	Coal	94	71,000	27,000	35,500,000
Tupelo	Clear Boggy Creek	Coal	380	280,000	93,000	83,160,000

1/ Source: Hydrologic data from table IX-3.
2/ Subappraisal costs for the represented multipurpose dam and reservoir.
3/ Yield, storage, and costs not estimated; this site will be evaluated for hydropower potential.
4/ Estimated drainage areas.
5/ Interim feasibility study completed in November 1975, Corps of Engineers.

Table IX-24
Projected Need for Additional Generating Capacity to Meet SPP Load Growth 1/ [1992 to 2002] 2/
(East-Central Oklahoma Water Supply Study, January 1985)

Year	Estimated Peak Demand Requirements (MW)	Required Capabilities Including Reserves (MW)	Scheduled Capability (MW)	Net Need (MW)
1992	59,999	74,941	74,941	-0-
1993	61,800	77,250	74,941	2,309
1994	63,650	79,560	74,941	4,619
1995	65,560	81,950	a74,941	7,009
1996	67,525	84,405	74,941	9,464
1997	69,550	86,940	74,941	11,999
1998	71,635	89,545	74,941	14,604
1999	73,675	92,345	74,941	14,404
2000	76,000	95,000	74,941	20,059
2001	78,280	97,850	74,941	22,909
2002	80,630	100,790	74,941	25,849

1/ SPP = Southwest Power Pool which includes the states of Oklahoma, Arkansas, Louisiana, and Kansas as well as portions of Mississippi, Missouri, Texas, and New Mexico.
2/ Tabulation from Corps handout at the Second Interagency Planning Meeting, Tulsa, Oklahoma, June 19, 1984.

Table IX-25

Previously Identified Potential Hydropower Sites

(East-Central Oklahoma Water Supply Study, January 1985)

Site	Stream	Location	County	Drainage Area (mi²)	Net Head (ft)	Average Flow (ft³/s)	Plant Factor (%)	Unit size (mW)	Average Annual Energy (GWh/yr)
Lela [1]	Black Bear	36°20.6' 96°50.6'	Pawnee	545	60.4	167	15	1.9	2.5
Welty [2] [1]	Deep Fork Deep Fork	RM 30.2 35°38.0' 96°23.5'	Creek	1,395 1,485	43 48.8	540 605	27.0 27.0	6.3 4.5	14.8 10.4
Tuskegee [2]	Deep Fork	RM 117.6	Okfuskee	1,510	83	580	23.2	15.1	30.7
Boley [1]	N. Canadian	35°26.3' 96°31.7'	Okfuskee	13,970	20	657	31.0	2.1	5.7
Hickory Ridge [1] (Wetumka)	N. Canadian	35°17.7' 96°12.8'	Okfuskee	14,290	20	671	31.0	2.1	5.8
Oxbow [2] (Wetumka)	Wetumka	--	Hughes	408	43	200	5.0	12.5	5.5
Sasakwa [2] [1]	Little River	RM 24.1 34°59.0' 96°32.5'	Seminole	865 869	63 69	250 353	4.2 22.0	27.1 3.3	10.1 6.5
Asher [1]	Canadian	34°55.9' 96°53.5'	Pottawatomie	26,900	15.0	1,545	25.0	3.6	8.1
Byng [1] (Konawa)	Canadian	34°54.8' 96°39.2'	Seminole	26,980	15.0	1,550	25.0	3.6	8.1
Ada [2]	Sandy Creek	--	Pontotoc	191	83	50	3.3	9.1	2.6
Parker [2] [1]	Muddy Boggy	RM 127.4 34°45.0' 96°17.0'	Coal	172 172	68 66	135 145	4.9 17.0	14.9 2.3	5.9 3.3
Tupelo [2] [1]	Clear Boggy	RM 73.5 34°30.0' 96°21.5'	Coal	380 380	34 66	235 243	5.9 26.0	9.9 2.5	5.1 5.7
Nuyaka [1] (Weleetka)	Deep Fork	35°39.0' 96°11.0'	Okmulgee	2,146	59.1	875	36.0	4.1	13.1

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[1] Reclamation's Western States Inventory of Low-Head Hydroelectric Sites (Phase II), October 1980.

[2] Corps of Engineers' "Red River Basin and South-Central and Southeast Oklahoma Comprehensive Studies, Second Interagency Planning Meeting, Tulsa, Oklahoma," June 19, 1984.

supplies. This information should include, but not be limited to, legal descriptions of service area boundaries; data on water supply source(s) (reservoirs, wells, pipelines); average daily and peak demand use data; current description data on treatment, storage, and distribution facilities; present rate strucures; current indebtedness; problems with quantity or quality of water supply; anticipated expansion or rehabilitation of facilities along with estimated cost (if available); and information concerning planned expansion or curtailment of service area.

2. Local system deficiencies. Significant numbers of local water systems were found to have serious problems with inadequate treatment plant and storage capacities, leaks, undersized water-mains and lines with associated pressure loss and inability to deliver desired volumes, and age-deteriorated systems or antiquated facilites. These deficiencies are important for three reasons:

a. They result in water shortages during peak demand periods,

b. The customer has to pay higher water rates for which no benefit is received, and

c. Costs of replacement and repair put an additional drain on already limited public sector funds available for water resources.

3. Water quality problems. Much of the study area's available surface and ground water supply has significant water quality problems, making it less likely that plans can be formulated for cost-effective development for public drinking water supplies. Many of the areas water supplies have experienced problems in exceeding primary and secondary drinking water standards. Others have nonhealth-related quality problems such as extreme hardness, taste, odor, and staining. There is a need to assist these entities in determining the most cost-effective or acceptable solution from the choices of treatment, augmentation (dilution) with better quality water, or replacement with a better supply.

4. Unmet present and future M&I water supply needs. Preliminary investigations have identified 30 entities that are sources of M&I water supplies that need additional water supplies to meet current or projected water demand needs. An additional 10 entities have been identified for further investigation to determine the exact amount and priority need. There is potential for identification of additional water supply needs as water quality investigations progress in determination of need for augmentation or replacement supplies.

5. Irrigation needs. Agriculture holds some of the greatest potential for study area economic development. It appears certain that irrigation will be a component of that development. Further investigation is needed to determine adequacy of existing supplies and need for development of additional supplies.

6. Hydropower needs, Regional needs are already known. Projections of future hydropower needs for the local study area are required if economic development plans are to benefit.

7. Undetermined needs. This study has not progressed far enough to assess needs or incorporate information from other agencies to state study area needs for navigation, flood control, recreation, and fish and wildlife preservation and enhancement.

CHAPTER X - FINDINGS AND CONCLUSIONS

A. Findings

Human resource problems and needs identified are:

1. Per capita income in the study area is significantly below State and national levels.

2. Private sector economic activity is limited in much of the study area, resulting in public sector payrolls (local, State, and Federal government) providing more earnings (in six out of nine counties) than any single private sector component such as trade, manufacturing, mining (including extraction of oil and gas), and services.

3. Unemployment in the study area is not uniform, with six out of nine counties having significantly higher unemployment rates than the State or Nation.

4. Lack of economic opportunity has resulted in long-term outmigration in much of the study area which has resulted in more than a 50-percent population loss in some cases.

5. The better educated young people with current high-technology job skills training needed for economic development initiatives are the very people leaving the study area.

6. The remaining local population appears to be somewhat older with less formal education than State and national norms.

7. There appears to be a very limited tax base to finance all components of a comprehensive long-range economic development plan.

8. Population projections show that continuation of historic and present trends (OESC projections) will result in the continued decline of some of the study area counties and stagnation or eventual decline for many communities during the next 50 years.

9. The SEDIP population projections show that a sustained, 50-year coordinated economic development effort by study area communities, interest groups, counties, economic development planning districts, and RedArk could result in healthy growth of the region, alleviating many of the problems and providing the study area with an opportunity to participate equally with the rest of the State in future prosperity.

The known cultural resources of the East-Central Oklahoma Water Supply Study area only hint at its use through time by various groups. Enough survey has been completed in the study area during the last 10 years to indicate the diversity of cultural material present, particularly in areas considered as potential water resource development sites. The need to locate/identify presently unknown sites and thoughtfully examine a cross section of these is great. Much has been lost to development, farming, and erosion caused by farming activities during the past 50 years. Future expansion will intensify the problem. The opportunity exists to identify important sites and document their use within the context of this study.

Regional analyses of the study area's recreation and tourism facilities indicate significant, moderate priority needs for golfing, baseball, picnicking, hunting, canoeing, hiking, and RV camping facilities development. Nearly all of the nine-county study area has no easily accessible State or Federal recreation facility development. Ongoing investigations should recognize and address these regional recreational needs as well as localized needs which may be satisfied through multipurpose water resource development. The nine-county east-central Oklahoma study area is almost totally rural in nature and notably lacking in currently identified unique, sensitive, or public environmental resources of national or regional significance. Noted environmental problems relate more to a trend of general wildlife habitat loss and water quality-streamflow regulation problems than to environmental resources given specific protection by Federal or State law. There are no federally listed endangered or threatened species (except for migrants) and a limited number of existing publicly owned resources of an environmentally sensitive nature. However, the area lies on the fringes of the Oklahoma City and Tulsa metropolitan areas, is crossed by major interstate access routes (I-40 and I-44), and has great potential for future economic development. Land use changes, due to agricultural, mineral, or industrial development, have modified much of the presettlement wildlife habitat within the region.

Surface water pollution from oilfield brine disposal and urban effluent has affected and will probably continue to affect the species assemblages and productivity of area streams. Potential water resource development may cause additional losses of important fish and wildlife habitats but also may provide the means for preservation or restoration of modified habitat through multiple resource development and management.

Problems with mineral resources appear to be:

1. Current forecasts indicate the study area's presently known oil and gas reserves will become depleted within the next 10 to 20 years. Deep wells, isolated deposits, and additional secondary and tertiary recovery from old fields, heretofore too costly to undertake, will become cost feasible when depleting world supplies result in rising prices. These same high prices will also constrain output to a fraction of present production, which will be a disastrous blow to the study area's and State's economic vitality. A great deal of effort will be required to generate enough economic development to replace the earnings and tax base that will be lost to the study area.

2. Neither study area county having coal deposits is presently producing any commercial tonnage. Given constraints of type of coal and location, the downturn in domestic steel production, and cost factors associated with antipollution equipment needed to burn this coal, there appears to be little economic incentive to reinstitute active coal mining in the two study area counties. Unless future technology provides less costly emission controls for power-generating plants or escalating energy prices make methane gas recovery or synthetic fuel production commercially feasible, there appears to be little hope for substantive development of coal production in the study area.

3. With dwindling available supplies of petroleum and natural gas at much higher prices and serious questions about the region's coal being able to replace it at an economical price, the study area needs to concern itself with how it will replace its own energy needs at an affordable price. The one largely untapped energy resource in the study area (other than solar energy), which is in ample supply, is flowing water which has the additional advantage of being a constantly renewable resource. A serious, comprehensive effort needs to be undertaken immediately to determine how hydroelectric power might be used to supply the study area with low-cost electric power as a replacement for fossil fuel energy.

Land, agricultural, and forestry resources present the following problems and needs:

1. Preliminary studies revealed approximately 220,600 acres have potential for irrigation development. Further investigation is needed as to how this potential might be best utilized or developed for optimal contribution to economic development in the study area. Types of development to be evaluated should include both private individual and large project-type developments. Large projecttype developments evaluated should include both Federal and non-Federal development. Reclamation should make appropriate recommendations based on findings.

2. Investigate potential for development of irrigated specialty crop enterprises. Reclamation will work with OSU, SCS, county agents, and other agriculturalists in this area.

3. Investigate, develop, and demonstrate more efficient irrigation management methods.

4. Fully investigate the potential for development of forest products. Although the potential for primary forest products industries may be limited due to limited forest resources, there is a need to encourage additional secondary forest products industries in the study area since it presently contains one-third of the State's firms engaged in such enterprises.

Findings for industrial development are:

1. The economy of the project area is less developed than that of the State or the United States as a whole. There are substantially fewer employment opportunities in the manufacturing and trades and services sectors of the project area economy, which have kept per capita incomes significantly below State and national averages. Higher than average percentages of employment exist in agriculture and State and local government as a result of this phenomenon. Working age residents are continuing to leave the study area in search of employment, especially those who have earned high school and post-high school degrees. In order to strengthen the economy of the project area, more effort needs to be focused on the creation of new job opportunities in the manufacturing sector, which will then generate more employment in the trades and services sector and improve the balance and overall health of the area economy.

2. The economic analysis and inventory of manufacturing activity indicates that a dichotomy exists within the study area. The western portion of the area has greater population density, better highway and rail access, and available investment capital from past industrial development successes. However, these development amenities are lacking in the eastern portion. The western portion should respond to an intensive job creation program, while the eastern portion of the study area will require more basic economic development efforts to prepare for economic growth in the future.

Several innovative approaches to job creation have been initiated because traditional industrial development efforts have not yielded anticipated results in some of the study area. A REDC and an ITRAD have been established to aid businesses expansion efforts, develop new business based upon innovative technology, stimulate the creation of new jobs through vendor contracts, provide financial consultation and packaging services, and provide a source of new debt and equity capital to help finance these ventures. Additionally, REDC has established industry incubators in area vocational-technical schools to help train prospective employees for new enterprises in the region, and an entrepreneurship curriculum has been created to promote a better understanding of the free enterprise system's expectations and requirements.

3. Industrial development organizations exist in nearly every county and community in the study area, and local commitment is necessary to successfully attract new job opportunities. These local groups can play a very important role in convincing prospective employers that their communities will actively assist and support new development activity.

4. When a firm decides to either expand or relocate, it can choose among any number of areas which are fully prepared to meet the firm's requirements. Some communities in the study area are now at a competitive disadvantage to vie for new firm locations or expansions because of some or all of the following barriers:

a. Poor transportation networks,

b. Lack of a sufficiently large and trained labor force,

c. Lack of existing industrial infrastructure, and

d. Lack of an organized industrial promotion effort.

5. The following recommendations for stimulation of new employment opportunities take into consideration the current range of development efforts ongoing within the project area. A basic approach to preparedness preparation for economic development in smaller, less developed communities should be used to help overcome existing barriers to development.

6. A RIDA should be established to aggressively promote the creation of new jobs in the area. The RIDA can work closely with REDC and ITRAD in reaching this goal. Market analyses and feasibility studies provided through a cooperative arrangement with an area university or research center are needed to support this job creation effort. Training seminars for interested communities and local development groups could explain innovative financing, promotional techniques, and industrial service and facility needs.

7. Analyses of manufacturing industry characteristics reveal that growth in certain sectors of the study area's manufacturing industry would be more beneficial to the area's economic development. It was suggested that those leading efforts for study area industrial development should (a) encourage growth in the printing and publishing industry; (b) maintain efforts to revive the petroleum industry; (c) continue to build on success in developing the rubber and plastics products industry; especially in the area of miscellaneous plastics products; and (d) continue the growth trend in the nonelectrical machinery sector.

Findings for water resources are:

1. Federal, State, and Sub-State agencies all report difficulty in obtaining accurate needed data from smaller municipalities and rural water systems. A specific function within a State agency needs to be given specific clearinghouse responsibility for acquisition, analysis, and dissemination of all information concerning entities providing public drinking water supplies. This information should include, but not be limited to, such things as legal descriptions of service area boundaries; data on water supply source(s) (reservoirs, wells, pipelines); average daily and peak demand use data; current description data on treatment, storage, and distribution facilities; present rate structures; current indebtedness; problems with quantity or quality of water supply; anticipated expansion or rehabilitation of facilities along with estimated cost (if available); and information concerning planned expansion or curtailment of service area.

2. Significant numbers of local water systems were found to have serious problems with inadequate treatment plant and storage capacities, leaks, undersized water mains and lines with associated pressure loss and inability to deliver desired volumes, and age-deteriorated systems or antiquated facilities. These deficiencies are important for three reasons:

a. They result in water shortages during peak demand periods,

b. The customer has to pay higher water rates for which no benefit is received, and

c. Costs of replacement and repair put an additional drain on already limited public sector funds available for water resources.

3. Much of the study area's available surface and ground water supply has significant water quality problems, making it less likely that plans can be formulated for cost-effective development of these sources into public drinking water supplies. Water supplies provided by many of the area's water user entities experience problems in exceeding primary and secondary drinking water standards. Others have nonhealth-related quality problems such as extreme hardness, taste, odor, and staining. There is a need to assist these entities in determining the most cost-effective or acceptable solution from the choices of treatment, augmentation (dilution) with better quality water, or replacement with a better supply.

4. Preliminary investigations have identified 30 entities that are sources of M&I water supplies that need additional water supplies to meet current or projected water demand needs. An additional 10 entities have been identified for further investigation to determine the exact amount and priority of need. There is potential for identification of additional water supply needs as water quality investigations progress in determination of need or desire for augmentation or replacement supplies.

5. Agriculture holds some of the greatest potential for study area economic development. It appears certain that irrigation will be a component of that development. Further investigation is needed to determine adequacy of existing supplies and need for development of additional supplies.

6. Regional hydropower needs are already known. Projections of hydropower needs for the local study area are needed if economic development plans are to benefit.

7. This study has not progressed far enough to assess needs or incorporate information from other agencies to state study area needs for navigation, flood control, recreation, and fish and wildlife preservation and enhancement.

8. The study area has average annual runoff of 5.5 inches, which assures ample available flows in its numerous streams and rivers. Approximately 30 previously identified potential damsites have been noted and given very preliminary study for ability to provide water supplies. Although some of these sites will probably be eliminated from consideration for economic, engineering, and water quality reasons as well as adverse impacts on the environment or cultural resources, the large number of streams in the study area appear to assure that suitable water supply reservoir sites can be found reasonably near identified demand centers.

B. Conclusions

Since this planning guide represents only a few months' efforts at preliminary resource inventory and assessment of problems and needs, the following conclusions represent only a summation of preliminary resource inventory results and initial identification of study area problems and needs that should be addressed during the remaining 3-1/2 years of this study.

Human needs. The basic contention underlying all of RedArk's comprehensive economic development planning and implementation is that the 24-county RedArk project area (which includes the 9 counties in this study) has significantly lagged behind the rest of the State and Nation in economic development. Findings listed earlier in this chapter clearly indicate conditions associated with significant economic underdevelopment, validating the need for comprehensive economic development for the study area. Further analyses should be undertaken to determine whether the study area's socioeconomic problems will support a request for authority to formulate plans of development for Regional Economic Development (RED) objectives instead of the normally required formulations for National Economic Development (NED) objectives.

Water resources. There is a need to have a specific function within a State agency charged with the responsibility of acting as an information clearinghouse for all entities providing public drinking water supplies. It should have direct responsibility for acquisition, analysis, and dissemination of accurate, current, and complete information for all entities as discussed in chapter IX.

Many of the study area's surface and ground water supplies have significant water quality problems. This results in the need to assist entities in determining the most cost-effective or acceptable solution from the choices of treatment, augmentation with better quality water, or replacement with a better supply.

The abundance of undeveloped streams with ample flows and the identification of 30 potential damsites from previous studies assures that water supplies more than adequate to meet all projected needs can be developed reasonably near all demand centers. This will still be true even if it would be necessary to eliminate a number of damsites from further consideration due to water quality, economic, or engineering problems.

There are 30 M&I study area entities that are sources of M&I water supplies that need additional water supplies to meet current or projected water demands. There are an additional 10 entities that require additional studies to determine the exact amount and priority of need plus the potential for identification of additional water supply demands as water quality investigations reveal needs for augmentation or replacement supplies.

Agriculture holds some of the greatest potential for economic development in the study area; therefore, further investigation should be carried out to determine adequacy of existing supplies and need for development of additional supplies for individual and project-type irrigation.

Projected regional needs, alone, justify additional study of hydropower; and 13 previously identified potential sites assure that likely sites do exist. Determination of present and projected local study area hydropower demands for replacement energy due to declining petroleum and natural gas reserves and additional energy requirements to support economic development need to be accomplished.

As this study progresses, assessment of needs should be completed or incorporated from other agency information to state study area needs for navigation, flood control, recreation, and fish and wildlife preservation and enhancement for inclusion into the plan formulation process.

Significant numbers of local water systems have been found to have serious problems with inadequate water treatment, storage, and distribution systems that must be rehabilitated, expanded, or replaced in order to assure ability to deliver adequate amounts of water when needed. These needs should be incorporated into the comprehensive economic development plans for the study area.

Land, agricultural, and forestry resources. Further investigation needs to be made on how the 220,600 acres of land identified as having the greatest potential for irrigation development might be best utilized or developed for optimal contribution to economic development in the study area. There is a need to study how specialty crop enterprises (especially fruits, berries, nuts, and vegetables) might contribute to agriculture's role in economic development. Reclamation plans to work with OSU and SCS activities in this area that involve irrigation, especially if needs for additional irrigation water supplies are identified.

Investigate, develop, and demonstrate more efficient irrigation management methods.

Fully investigate the potential for development of forest products. Although the potential for primary forest products industries may be limited due to limited forest resources, there is a need to encourage additional secondary forest products industries in the study area since it presently contains one-third of the State's firms engaged in such enterprises.

Environmental resources. No public, technical, or institutional environmental quality features have been identified which would constrain new water resource development within the east-central study area if adequate consideration for general environmental resources of high value is given as this study progresses.

Cultural resources. Known cultural resources of the study area only hint at its use through time by various groups. There is evidence indicating a diversity of cultural material present that is being lost to development, farming, and erosion. Of particular importance is the evidence of historic Indian settlement throughout the study area. This study presents an opportunity to identify important sites and document their use.

Recreation and tourism resources. Ongoing investigations should recognize and address identified regional and, possibly more important, localized needs which may be satisfied through multipurpose water resource development.

Mineral resources. There are ample supplies of nonmetallic industrial minerals to sustain present or expanded economic activity. Some current forecasts indicate that the study area's presently known oil and gas reserves will be depleted within the next 10 to 20 years and that prospects for resumption of coal mining in the study area are uncertain. A serious, comprehensive effort needs to be undertaken immediately to determine how hydroelectric power might be used to supply the study area with lower-cost electricity as a replacement for fossil fuel energy.

Industrial development. The study area contains a number of municipalities (Stillwater, Shawnee, and Ada) that have already experienced success in attracting or developing new industries as well as some smaller, less-developed communities. RedArk has been instrumental in developing action plans and strategies for the special needs of both types of communities. Analyses of manufacturing industry characteristics have resulted in formulation of a list of most desirable manufacturing sectors for the study area as a guide for groups promoting industrial development.

C. How the Findings and Conclusions Will be Carried Out

As stated earlier in this chapter, this report sets forth the results of preliminary resource inventory and initial identification of study area problems and needs that should be addressed during the remaining 3-1/2 years of this study. Additional information concerning the planning process to be followed during the remainder of this study, how the public is to be involved in this process, how the study is organized and managed, and what the interested citizens or groups can do is provided below.

1. Planning process. All Federal water and associated land resource development planning must follow a process set forth in what is known as the Principles and Guidelines (for water resource planning). In this planning process, a designated study area will have its water-related needs identified and its resource capability to meet those needs quantified. With this information, realistic planning objectives are defined. A variety of alternative plans are formulated to meet each objective or combinations of objectives in order to develop a range of choices. Analyses of the alternative plans are made to determine which alternatives are viable plans. The viable alternatives are further refined before undergoing a procedure to select a "preferred" plan. The "preferred" plan then undergoes additional refinement required to become the recommended plan for Federal construction and development. Public involvement and input to the decisionmaking process is required throughout the planning process.

2. Public involvement. Public involvement includes two groups. The first group involves Reclamation's continuous working relationship with State and local government agencies (including rural water districts) as well as regional planning and development groups. The second group will be the general public whom Reclamation will keep informed of study progress by the local news media, study brochures, and public meetings where people will be encouraged to express their views.

3. Study organization and management. This 4-year study is being conducted under the leadership of Reclamation--an agency of the Department of the Interior which has the mission to assist other Federal agencies, States, local governments, and regional organizations in stabilizing and stimulating local and regional economies; enhancing and protecting the environment; and improving the quality of life through development of water and related land resources throughout the 17 Western States. Reclamation's Southwest regional office, headquartered in Amarillo, Texas, is conducting the study using a study team composed of a study manager and technical experts in the fields of archeology and historical preservation, economics, engineering, environmental science, geology, hydrology, recreation planning, sociology, soil science and land resources, and technical writing. The Reclamation study planning team has assistance available from Oklahoma resource planning agencies, local entities, and other Federal agencies. In two counties (Lincoln and Okfuskee) where investigations overlap, Reclamation will lead a joint-study effort with the Corps under terms of a Memorandum of Agreement to assure respective planning activities complement, rather than duplicate, each other. Because of the large size of the study area, Reclamation is using contractors to assist in gathering data on the existing environmental conditions; archeological and historical resources present; and a social assessment that includes identification of public attitudes, values, and ideas on the area's problems and needs.

4. What the interested citizens or groups should do. First, plan to attend the public meetings that will be held in the study area so that more can be learned about the study and views expressed. Second, views should be expressed to elected and appointed officials, community leaders, and local or regional planners. Third, if there is any information which should be considered, any opinions regarding aspects of this study, or a desire to participate in the planning process, an invitation is extended to share these ideas and interests with Reclamation by contacting:

Regional Director
Bureau of Reclamation
U.S. Department of the Interior
714 South Tyler, Suite 201
Amarillo, Texas 79101

Oklahoma Representative
Bureau of Reclamation
U.S. Department of the Interior
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Oklahoma City, Oklahoma 73102

REFERENCES

(Ayensu and DeFilipps 1978) - Ayensu, E. S. and R. A. DeFilipps, Endangered and Threatened Plants of the United States, Washington, D.C., Smithsonian Institution and World Wildlife Fund, Inc., 1978.

(Barr 1963) - Barr, T. P., Archeological Survey of Project 12, Camp-Salt Creek Watershed, Lincoln and Creek Counties, Oklahoma, General Survey Report No. 3., University of Oklahoma Research Institute, Norman, Oklahoma, 1963

(Bell 1984) - Bell, R. E., editor, Prehistory of Oklahoma, Academic Press, Orlando, Florida, 1984.

(BOIC 1898) - Twenty-Ninth Annual Report of the Board of Indian Commissioners, 1897, Washington Government Printing Office, Washington, D.C., 1898.

(Brabander and Masters 1984) - Brabander, J. J. and R. Masters, Bottomland Hardwoods of Eastern Oklahoma, a Special Study of Their Status, Trends, and Values, U.S. Fish and Wildlife Service, Tulsa, Oklahoma, and Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma, 1984.

(Cheek et al. 1974) - Cheek, A. L. et al., editors, An Archeological Assessment of Proposed Kickapoo Nations and Robinson Creek Watersheds, Lincoln and Oklahoma Counties, Oklahoma, Archeological Research Associates, Tulsa, Oklahoma, 1974.

(Cheek et al. 1974) - Cheek, A. L. et al., preparers, An Archeological Survey of the Upper Muddy Boggy Watershed, Pontotoc, Coal, and Hughes Counties, Oklahoma, University of Tulsa, Department of Sociology and Anthropology, Tulsa, Oklahoma, 1974.

(Cheek and Cheek 1975) - Cheek, A. L. and C. Cheek, editors, A Preliminary Archeological Assessment of the Central Oklahoma Project Area, Archeological Research Associates, Tulsa, Oklahoma, 1975.

(Cowardin et al. 1979) - Cowardin et al., Classification of Wetlands and Deepwater Habitats of the United States, U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C., 1979.

(Duck and Fletcher 1943) - Duck, L. G. and J. B. Fletcher, A Survey of the Game and Furbearing Animals of Oklahoma, Oklahoma Game and Fish Commission, State Bulletin No. 3, Oklahoma City, Oklahoma, 1943.

(Gettys 1985) - Gettys, Marshall, personal communication, State Historic Preservation Office, Oklahoma City, Oklahoma, 1985.

(Lewis et al. 1975) - Lewis, J. C. et al., Rare and Endangered Vertebrates and Plants of Oklahoma, Soil Conservation Service, Stillwater, Oklahoma, 1975.

(MECA 1972) - Mid-Continent Environmental Center Association, Environmental Inventory and Assessment of the Central Oklahoma Project Study Area, Contract DACW56-72-C0062 for U.S. Army Corps of Engineers, Tulsa District, 1972.

(Miller and Robison 1973) - Miller, Rudolf J. and Henry W. Robison, The Fishes of Oklahoma, Oklahoma State University Press, Stillwater, Oklahoma, 1973.

(Morris 1977) - Morris, J. W., Ghost Towns of Oklahoma, University of Oklahoma Press, Norman, Oklahoma, 1977.

(Morris et al. 1976) - Morris, J. W. et al., Historical Atlas of Oklahoma, University of Oklahoma Press, Norman, Oklahoma, 1976.

(Neal 1972) - Neal, Larry, "An Archeological Survey and Assessment of the Prehistoric Resources in the Albany and Parker Reservoirs, Oklahoma," Oklahoma River Basin Survey, Norman, Oklahoma, 1972.

(Neal 1985) - Neal, Larry, personal communication, "Oklahoma Archeological Survey," Norman, Oklahoma, 1985.

(OSCC 1960-1984) - Index to Archeological Survey Reports and Manuscripts from Assessments of USDA Soil Conservation Service Watershed Projects in Oklahoma, Oklahoma Soil Conservation Commission, Oklahoma City, Oklahoma, 1960-1984.

(OTRD 1982) - Oklahoma Tourism and Recreation Department, State Comprehensive Outdoor Recreation Plan, Oklahoma City, Oklahoma, 1982.

(SI 1975) - Smithsonian Institution, Report on Endangered and Threatened Plant Species of the United States, U.S. House of Representatives, 94th Congress, 1st Session, H. Doc. 94-51, 1975.

(USDI 1972) - U.S. Department of the Interior, The National Register of Historic Places, National Park Service, Washington Government Printing Office, Washington, D.C., 1972.

(USDI 1974) - U.S. Department of the Interior, The National Register of Historic Places, Addendum, National Park Service, Washington Government Printing Office, Washington, D.C., 1974.

(USDI 1980) - U.S. Department of the Interior, Endangered and Threatened Wildlife and Plants of Texas and Oklahoma, U.S. Fish and Wildlife Service, Region 2, Albuquerque, New Mexico, 1980.

(USDI 1980) - U.S. Department of the Interior, National Survey of Fishing, Hunting, and Wildlife - Associated Recreation, Oklahoma, U.S. Fish and Wildlife Service in Cooperation with Bureau of the Census, 1980.

(USDI 1982) - U.S. Department of the Interior, Natural Rivers Inventory, Natural and Free-flowing Phase, Heritage Conservation and Recreation Service, Albuquerque, New Mexico, 1982.

(USDI 1983) - U.S. Department of the Interior, National Register of Historic Places, Annual Listing of Properties - January 1979 through December 1982, National Park Service, Washington Government Printing Office, Washington, D.C., 1983.

(USDI 1984) - U.S. Department of the Interior, National Register of Historic Places: Annual Supplemental Listing of Historic Properties, National Park Service, Washington Government Printing Office, Washington, D.C., 1984.

(USDI 1984) - U.S. Department of the Interior, Planning Aid Report on the Red River Basin and South-Central and Southeast Oklahoma Comprehensive Study, U.S. Fish and Wildlife Service, Tulsa Ecological Services, Tulsa, Oklahoma, October 1984.

(USDI 1984) - U.S. Department of the Interior, Planning Aid Report on the East-Central Oklahoma Water Supply Study, U.S. Fish and Wildlife Service, Ecological Services, Tulsa, Oklahoma, February 1985.

(Wallis 1979) - Wallis, C. S., Jr., Report on the Status of Archeological Survey Work, Okfuskee County Tributaries Watershed Project, Okfuskee County Portion, General Survey: Report (1979:1), Oklahoma Conservation Commission, Oklahoma City, Oklahoma, 1979.

(Wallis 1981) - Wallis, C. S., Jr., Archeological and Historical Review of Multi-Purpose Impoundment 4M Robinson Creek Watershed, Lincoln County, General Survey Report (1981:5), Oklahoma Conservation Commission, Oklahoma City, Oklahoma, 1981.

(Wyckoff and Brooks 1983) - Wyckoff, D. G. and R. L. Brooks, Oklahoma Archeology: A 1981 Perspective of the State's Archeological Resources, Their Significance, Their Problems and Some Proposed Solutions, Oklahoma Archeological Survey, Norman, Oklahoma, 1983.

(Zanoni et al. 1979) - Zanoni, Thomas A., Johnnie L. Gentry, Jr., Ronald J. Tyrl, and Paul G. Risser, Endangered and Threatened Plants of Oklahoma, University of Oklahoma, Norman, Oklahoma, 1979.

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